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THE ADVISORY COUNCIL ON SCIENTIFIC POLICY

THE Advisory Council on Scientific Policy was established in 1947 "to advise the Lord President of the Council in the exercise of his responsibilities for the formulation and execution of Government scientific policy". It is concerned accordingly not with administration but with the strategy of scientific affairs, and in its seventh annual report*, breaking with the practice of the two previous reports, the Advisory Council reviews its activities, including those of the current year, during the whole period since it was established, in the light of post-war developments. The Council was established in the recognition that to-day a country's wealth and power are largely determined by the extent of its scientific knowledge and by its capacity to use that knowledge. It was also realized that the scientific institutions of Britain had grown up piecemeal, and that, although much of their cost fell on the Exchequer, no single body was concerned with the oversight of Government scientific policy in general, with the interaction of new scientific developments—desirable in the national interests—among themselves and with the functions of existing institutions; nor with the responsibility of advising whether the supply of scientific man-power was adequate to meet the needs both of Government and industry.

The first, and major, part of the present report is concerned with the scale of the civil scientific research effort, and discusses the expansion of scientific education and the demand for scientists, including the shortage of science teachers, and next the scale of Government-financed research. The fruition of policy, however, depends on the extent to which industrialists and farmers make use of advances in scientific knowledge, and on the extent to which scientific considerations are taken into account at the highest levels where policy is determined, in industry as well as in Government. The second part of the report, accordingly, reviews briefly the exploitation of the civil scientific effort both by Government Departments themselves and in industry.

The increase in the size of the universities of Britain, and, more particularly, the increase in the numbers of graduates in science and engineering, are, in the opinion of the Advisory Council, among the most noteworthy changes which have occurred in Great Britain during the past ten years. In 1952–53, the universities awarded 5,710 first degrees and diplomas in scientific subjects compared with 3,060 (including higher degrees) in 1938–39; for applied science the corresponding figures are 3,636 and 1,808, respectively; for medicine and dentistry, 2,369 and 1,792; and for agriculture, 803 and 246. Nor was 1952–53 the peak year for all subjects; only in chemistry were more honours degrees awarded in 1952–53 than in 1951–52. For pass-degrees and diplomas in pure science the peak was reached in 1950–51; in applied science it was earlier still—1949–50—and has de-

* Seventh Annual Report of the Advisory Council on Scientific Policy, 1953–1954. Pp. iv+23. (Cmd. 9260.) (London: H.M. Stationery Office, 1954.) 1s. net.

clined steadily since. Honours degrees in chemical technology have declined from 121 in 1950–51 to 100 in 1952–53, although in engineering sciences as a whole they have remained fairly steady (1,025 in 1950–51, 998 in 1952–53).

Discussing these figures in the light of the estimates of the Barlow Committee in 1946, the Advisory Council points out that, while over-cautious about the possibilities of increasing the output of trained scientists, the Barlow Committee was correct in predicting a continuing shortage, and that the position would become serious if the level of new investment in manufacturing industry increased and if the more backward sections of British industry began to employ trained scientists and engineers, not only in laboratories and workshops, but also in boardrooms and sales organizations. There is no indication, however, that the Advisory Council has attempted to estimate the future demand for trained scientists. Apart from discussions initiated by its Committee on Biology and Allied Sciences, the Advisory Council appears to have rested content with the survey made two years ago by its Scientific Man-power Committee, and to have made no further effort to obtain more accurate estimates from the various sub-committees of Lord Hankey's Technical Personnel Committee.

The Council is clearly concerned, however, as to the situation which might arise if investment increased materially, and if the demand for trained scientific man-power reached the proportions which might be regarded as adequate for a progressive industrial nation. There is evidence that the decline in the number of admissions to the universities since 1949–50 has been halted, although university departments in pure and applied science are now doing no more than maintain their student numbers. Numerically, the position of the technical colleges is more encouraging; the awards of National and Higher National Certificates are now about three and six times the pre-war figures, respectively.

Although about twice as many young men and women in each age-group are now going to the universities as compared with pre-war years, the ratio to-day (1 : 31 in each age-group) is still significantly less than in countries like Switzerland or the United States. The Advisory Council has no doubt as to the ability of the universities to cater for larger numbers and for an increased proportion of science students, provided the necessary resources are forthcoming. It assumes that such resources can be provided without detriment to other national interests, and in this survey its chief concern is with the possibility of stimulating more of the able boys and girls of the existing school population to take up science instead of the humanities, or encouraging those who leave school at or before sixteen to stay on until university age. It does not consider that there is much scope for attracting to science more of the present population of the sixth forms of grammar schools, and it is the second measure which offers the best prospect of materially increasing the supply of science undergraduates.

The Advisory Council has recently been told by the Ministry of Education and the Scottish Education Department that the number of boys staying on at school is increasing and that in grant-aided and recognized independent schools the number aged 17–18 rose from 23,000 in early 1950 to 27,500 in early 1953. This trend should bring to the universities more potential scientists as well as more potential first-class scientists; but, even taking into account the effect of the post-war bulge in the birth-rate, which from 1960 could give a 25 per cent increase in university students, the figures would have to increase far more to affect materially the number of trained scientists. Moreover, the Council recognizes that there is a risk that such expansion may be at the expense of the numbers of those at present leaving school before the age of seventeen who continue their scientific and technical education on a part-time basis.

Such recognition, however, is as near as the Advisory Council comes in this report to emphasizing that the expansion of scientific and technological education in Britain must proceed in balance with the expansion of technical education, and that some attempt must be made to see that the demands of industry in respect of technicians are also met. The demands for technicians and for technologists and scientists, moreover, are not entirely independent, as in their supply they are interlocked. Indeed, the Advisory Council might well have directed attention to the importance of industry and Government, as well as the universities and research institutions, making the most effective use of their trained scientists. The demand could be checked at least a little if full care were taken to see that highly qualified men are not employed on work which can be carried out no less efficiently by those less highly trained.

In part, this depends on the availability of adequate numbers of laboratory and other technicians, and estimates of the requirements of industry or Government Departments for scientists or technologists which take no account of requirements for technicians are of little value. This consideration equally affects the supply of science teachers, as was fully recognized by the National Advisory Council on the Training and Supply of Teachers in its report on graduate teachers of mathematics and science; the Advisory Council on Scientific Policy endorses the measures recommended in that report in referring to the shortage of science teachers.

Any attempt to encourage more boys to stay on at school until of university age can be of only limited effect as a contribution to increasing the supply of scientists and technologists until the continuous decline in the numbers and quality of science teachers is checked. Broadly speaking, on the question of the shortage of science teachers, as on the supply of scientists, the Advisory Council's views are similar to those of the committee set up at the conference convened by the Federation of British Industries last January. Serious as is the present position, it will become even more serious in the next five or six years unless action is taken very quickly: by 1960 the deficiency of science teachers in the schools may reach 2,300. The Advisory Council believes that so long as there is a real shortage of

scientists, the prevailing salary scales will not attract sufficient numbers to teaching. The poor career prospects in comparison with those in industry or Government service are the basis of the shortage, and this report supports the proposals made by the Federation of British Industries Committee for salary revision which would open up prospects of salaries up to £1,500 for, say, five per cent of science graduates engaged in teaching. It gives no indication, however, of the Council's attitude to the more controversial issue of deferment of National Service, on which the Federation of British Industries Committee suggested a reasonable compromise.

The Advisory Council insists that a solution to this problem of the shortage of science teachers is essential; it does not appear to stress sufficiently that a price must be paid to remove the threat which the shortage offers to the supply of trained scientists and technologists, which conditions so largely the effectiveness of our national economy, even if that price be no more than that involved by the proposals of the Federation of British Industries Committee. That price will only be kept so low, however, if vigorous concerted action is taken to promote the ameliorative measures suggested by the Advisory Council or in the reports by other bodies such as the National Advisory Council on the Training and Supply of Teachers and the Federation of British Industries Committee. For example, the Advisory Council, in pointing out that the need is not for narrow specialists in science, suggests that the universities themselves could, by insisting on a proper standard of general education for all candidates, both check over-specialization in the schools and ease the difficulty of finding specialist science teachers for schools. It also comments that, while the standard of first degrees in scientific subjects should be maintained, the proportion of better students who take up science would rise if the universities made it easier for those who had specialized in the humanities at school to turn to science when they reach the universities.

These are sensible suggestions, and it would seem that the *studium generale* or exploratory year which is under trial at the University College of North Staffordshire may have something to offer in this connexion. The Advisory Council, moreover, reaffirms that it is not deprecating the importance of the humanities in the universities, though it believes that education in science is as likely to provide an intellectual stimulus as an education in the classics or history. The emergence of the competent and open-minded man of judgment depends more on the quality of the individual himself and on the quality of the education he has received than on the curriculum.

The Advisory Council has found no evidence that Britain is losing an undue proportion of our best students to other countries, and it points out that the exchange of scientists and technical men between Britain and other Commonwealth countries is desirable on many grounds. The United Kingdom has probably done more to extend the scale of science education since the War than any other major Power; but we had more leeway to make up and were faced with a sterner challenge in maintaining our standard of living. We have still to plan to meet the need for scientists which is implicit in the view that our economy will grow at a reasonable rate and that there will be a rapid increase in our productivity. The Advisory Council rightly remarks that, in the long run, we need more people studying science because of its general educational value; but meanwhile, if a better balance between the supply and demand for scientists and technologists is to be achieved, the various measures now being taken or considered must be implemented with considerably more drive than appears in this report. It must also be insisted that the price to be paid is one which must be met in full, even if sacrifices have to be made elsewhere.

To assess the magnitude of the national demand for scientists and technologists, however, some regard must be had to the national effort; but when the report comes to consider the scale of Government-financed research, its inadequacy is manifest. Now that the Lord President of the Council has become responsible for the Atomic Energy Authority, the Advisory Council will presumably in future have within its competence the bulk of research in applied nuclear physics. Even so, expenditure on defence research may well be on a scale which makes it difficult to assess independently the balance and distribution of the national research effort. The Government expenditure of £20·7 million on civil research in 1954–55, exclusive of the proportion of the £28 million for the universities which is spent on research, has to be set against expenditure on defence research of £160 million or more, and probably up to £100 million on research and development by industry in its own establishments; the chemical industry alone expends something like £12 million and employs some 3,300 scientists, compared with the 4,423 employed under the research councils, etc., according to this report.

Much of this effort lies, of course, strictly outside the scope of the Advisory Council on Scientific Policy, as civil research lies outside that of the Defence Research Policy Committee. At some level, however, the full extent of Government and industrial and defence commitments in research requires review in relation to resources, nor can the Advisory Council discharge its statutory responsibility to the Lord President without some regard to this over-all picture and the way in which it tends to change, as the report itself explicitly admits. The most interesting feature of the summary of research expenditure appended to the present report is indeed the variation which it reveals in the rate of expansion in different fields. While the grand total of Government expenditure on civil research increased roughly six-fold, from £3,640,000 to £20,720,100, between 1939–40 and 1954–55, that on industry and communications and on medical and health purposes increased more than tenfold, from £983,400 to £9,859,000 and from £223,100 to £2,364,600, respectively; while expenditure on research in agriculture, forestry, fisheries and food increased five times, from £1,243,300 to £6,423,600, and that on overseas research increased only from £750,000 to £1,411,200. As the Advisory

Council points out, the scale of Government-financed research in the civil field has increased over the past decade as much as has university education in general, though expenditure on defence research has trebled between 1950 and 1953. Moreover, the rate of increase in expenditure on Government civil research appears to be appreciably greater than that of industry as a whole on research. A survey carried out for the Federation of British Industries in 1950–51 indicated that some three hundred firms were spending £24 million on research and development, an increase of not more than fourfold on expenditure in 1938, although probably fifty per cent greater than in 1945–46. The Association of British Chemical Manufacturers' estimate of £11·2 million expended by the chemical industry as research and development in 1952 represents an increase of some 32 per cent on expenditure in 1948.

The Advisory Council does not in the present report raise the questions whether this relative trend in expansion of research under Government auspices as compared with research within industry itself is desirable, or whether it represents the distribution of man-power and resources likely to yield the best return from the point of view of productivity and the national economy. It recognizes very clearly, however, the implications of such expansion for its own responsibilities, and the section of this report concerned with the exploitation of the civil scientific effort indicates that the Advisory Council is rightly concerned to see that gaps or weaknesses in the national effort are duly repaired or strengthened. On the evidence of this report, the Council's strategy appears to be sound, even if measures to remedy some of the weaknesses it notes might well have been advocated more forcefully. For example, the Advisory Council recognizes the importance of an efficient library service in the exploitation of the results of research, and that it must accept some responsibility for seeing that the national system is adequate and efficient. Nevertheless, in regard to the proposed Science Centre in London, it merely expresses an earnest wish that the necessary resources will be found shortly, and the hope that steps can be taken to implement the scheme for a national library of science and invention without undue delay. The present report will at least keep before the Government the interlocked proposals for a science centre and a central scientific reference library, and what is said in it may encourage Sir Robert Robinson to make a further effort to secure action on the proposals which he did so much to formulate.

The Advisory Council clearly does not regard the time and money required to implement the proposals as valid reasons for delay in bringing these plans to fruition at an early date, and the way in which these plans are related to the dissemination of the results of research and thus to scientific and technological progress may perhaps induce the Government to regard the matter as urgent and of high priority. At present, scientific library facilities in Britain are markedly inferior to those in the United States and in some European countries. The Advisory Council's Standing Committee has been closely concerned in efforts to overcome the immediate difficulties of the Patent Office Library and the Science Library at South Kensington, and during the past year has reported further to the Advisory Council regarding a national library of science and invention. The main recommendations of the report have been endorsed by the Advisory Council, and those quoted by the Council in its present report set forth concisely the case for early action.

The need for a national science lending library cannot be met either by a national science reference library in London or by the development of any existing library on its present site. In the interests of security, the new library should be outside London, preferably in a place easily accessible to the industrial areas of the North and Midlands, for which it could, to a limited extent, also serve as a scientific reference library. Existing collections in the Science Museum, after providing for the needs of the Kensington museums and of the Imperial College of Science and Technology, could supply much of the material for the new library, responsibility for which would be vested in the Department of Scientific and Industrial Research. The new library is thus visualized as an essential part of the expansion of that Department, and its work would be complementary to that of the Department's Intelligence Division, while it would also be the centre of a regional loans system based on selected municipal libraries which would stock and lend the three hundred or so periodicals most used by scientists and engineers in industry.

The bearing of these schemes on the efficient use of scientific and technical man-power might perhaps have been brought out more emphatically; but the Advisory Council's report at least affords the scientist as well as the industrialist an opportunity of pressing for early action by the Government in a matter vitally affecting the exploitation of the results of research, and one in which the first move must come from the Government. Generally, it would seem that the Advisory Council is satisfied with the arrangements to secure the use of science by Government Departments, though it would welcome an increase in the number of administrators with training and experience in scientific work who could bring an understanding of scientific matters to bear in the determination of policy. It also looks for increasing recruitment into the administrative Civil Service of men with a grounding in the sciences.

On the present record of its activities, it is clear that the establishment seven years ago of the Advisory Council on Scientific Policy has been amply justified; but it could be wished that at times it had raised its voice more emphatically and acted more vigorously, and that its influence had been more decisive. As its comments in regard to oceanographic research in this report illustrate, the Advisory Council is able to bring to bear, in borderline fields of science, an informed and concerted opinion and a co-ordinating influence much more immediately effective in implementing co-operation and closing gaps in our research effort than the delayed comments of the shrewdest and most alert Select Committee on Estimates or Committee of Public Accounts.

THE LIFE AND PHILOSOPHY OF ALMROTH WRIGHT

Almroth Wright : Provocative Doctor and Thinker
By Dr. Leonard Colebrook. Pp. xi+286+10 plates. (London : William Heinemann (Medical Books), Ltd., 1954.) 21*s*. net.

Alethotropic Logic : a Posthumous Work
By Sir Almroth E. Wright. Presented by Giles J. Romanes. Pp. xvi+346+4 plates. (London : William Heinemann, Ltd., 1953.) 25*s*. net.

THE task of writing a life of Sir Almroth Wright has been well discharged by Dr. Leonard Colebrook, his pupil and collaborator for many years. Wright was half Irish and half Swedish, and laid the foundations of his remarkable career as scientist, writer and philosopher by reading languages and law as well as medicine, and by an apprenticeship in experimental physiology and pathology before he became a bacteriologist.

Wright's greatest achievement was one of his earliest, the introduction of typhoid vaccine and his campaign for its adoption by the Army. He developed a series of ingenious techniques for studying the activity of leucocytes and the body's response to bacterial infection. An early result of these studies was the discovery of opsonin ; another was the formulation of views about the treatment of war wounds in 1914–18 which brought him into violent collision with the President of the Royal College of Surgeons. In this polemic he was deservedly described as a "savage controversialist". Of his advocacy of vaccines in the treatment, as distinct from the prevention, of infection, and of his later views on some aspects of immunity, little has survived in the belief and practice of the present day. Of the extensive vocabulary he coined, only two words, opsonin and prophylaxis, have come into general use. His techniques have been little copied, and the method of experiment in the whole animal has been preferred to those he devised employing only living blood *in vitro*. As Dr. Colebrook frequently points out, Wright's many ideas may yet bear fruit, or might have done so but for the revolution which has taken place in the treatment of bacterial infections. Chemotherapy has removed much of the need for other methods which he was trying to develop.

Wright was an innovator to whom progress in his science perhaps owes most because he was "provocative" of enterprise among both his associates and his opponents. His remarkable personal qualities secured him many friends and much influence outside his profession ; Bernard Shaw, for example, although contemptuous of orthodox medicine and disbelieving most of the doctrines on which Wright's work was based, had apparently a profound respect for him. The relations between these two men are well described, as indeed is all the more personal side of his life. This is a thoroughly readable and enjoyable biography, and from the scientific point of view it will be valued as a clear and simple account of a series of investigations which are not easy to follow in the original papers.

Wright's grandson, Dr. G. J. Romanes, his secretary, and four other colleagues and friends have collaborated in editing his last written work. "Alethotropic Logic" is an analysis of some of the workings of the human mind, and as such must be judged by psychologists and logicians. Its theme is the search for truth, and the basis on which truth should be accepted : the main argument can be shortly stated by the proposition that emotions are no basis for belief. Christian dogma is severely castigated in many places, as is the feminine mind, and, in Chapter 19, the orthodox statistical method in medicine. There are entertaining chapters or appendixes on the technique of writing, the defects of dictionaries, pictorial art, the relative degrees of intelligence of dogs and bitches, and some of the author's practical inventions. He employs many new words, mainly, like the adjective in the title, of Greek derivation : these are defined in a glossary. There are frequent quotations from a great variety of sources in five languages, admirably illustrating the argument and often epigrammatic. The book can be browsed in profitably for their sake alone, and it has the merit (itself dependent on the defect that this is a rather miscellaneous compilation) of presenting a more complete picture of the author than any other single work he wrote. One thing remains obscure. His favourite saying was : "God offers to every mind its choice between Truth and Repose". What God did he mean? Neither his own book nor his biographer's answers this question.

L. P. GARROD

ROTATING LIQUID MASSES

The Stability of Rotating Liquid Masses
By Dr. R. A. Lyttleton. Pp. vii+150. (Cambridge : At the University Press, 1953.) 35*s*. net.

A GIVEN mass of uniform incompressible liquid, acted upon by its own gravitation and no external forces, possesses only one configuration of equilibrium relative to a Newtonian frame of reference, and this configuration is a sphere. If the liquid is rotating relative to such a frame, with given angular momentum H, then, relative to a frame rotating with the liquid, there is a spheroidal configuration of equilibrium, a 'Maclaurin spheroid'. If H exceeds a certain critical value H_0, there is another configuration of relative equilibrium, a 'Jacobi ellipsoid'. If H does not exceed a certain further critical value H_1 ($>H_0$), there is still another equilibrium configuration which, when H_1–H is sufficiently small, is the 'pear-shaped' configuration discovered by Poincaré. When H is not too small, there are also configurations in which the liquid forms two bodies in equilibrium relative to a rotating frame ; it used to be thought that, for continuously varying H, the series of pear-shaped figures would be continuous with a series of such binary configurations.

Dr. R. A. Lyttleton's book is an account of the theory of the stability, with respect to arbitrary small disturbances, of the various (single-body) configurations. Two sorts of stability have to be considered, 'ordinary' and 'secular', the latter being relevant if there is any internal friction (viscosity) no matter how small. Although the existence of these two sorts is familiar in ordinary dynamics—for example, in the theory of a spinning top—there are pitfalls into which even the most eminent of previous writers on the present subject have stumbled. Dr. Lyttleton starts with an exceedingly lucid exposition of the theory of stability of a general dynamical system ; this should be noted by all applied mathematicians, whether or not they are interested in the present applications.

The classical investigations of the problems treated are those of Poincaré, G. H. Darwin, Jeans,

Liapounoff and Cartan. The main part of this book consists of a critical re-presentation of the essential theorems obtained by these writers, with some account of the special mathematical methods required. Here again, note should be taken of the general usefulness of Dr. Lyttleton's admirable summary of ellipsoidal harmonic analysis.

The results are, briefly, that the Maclaurin spheroid is thoroughly stable for $H < H_0$, but the secular stability passes to the Jacobi ellipsoid at $H = H_0$. The ellipsoid is thoroughly stable for $H_0 < H < H_1$ and thoroughly unstable for $H > H_1$. The pear-shaped figure is secularly unstable; it cannot, therefore, arise physically, and questions about its mathematical continuity with other forms have no physical significance.

The evolution of a rotating mass of liquid with constant angular momentum and slowly increasing density is the same as that of a mass with constant density and slowly increasing angular momentum. If, then, a rotating mass of liquid (with non-vanishing viscosity) is contracting slowly from an initial state of sufficient distension, it will evolve through the series of Maclaurin spheroids, until an ellipsoidal configuration is possible, and then through the series of Jacobi ellipsoids, until the last stable ellipsoidal configuration is attained. It will *not* then pass into a pear-shaped configuration and will not undergo fission into two bodies describing periodic orbits about each other. It must almost certainly break up, in some way which is not yet calculable, but the fragments must ultimately acquire orbits leading to infinite separation. These conclusions were first correctly formulated by Dr. Lyttleton himself and are cogently stated in his final chapter on "Cosmogonical Implications". This chapter offers some constructive suggestions about the possible rotational disruption of primitive planets and the formation of satellites in the solar system. But many readers will be more interested in the demonstration that binary stars cannot have been formed by rotational fission. A uniform liquid mass is, of course, an unrealistic representation of an actual star, but certain of Dr. Lyttleton's arguments are not restricted to this case and suffice to establish the result generally. In this connexion, Dr. Lyttleton justifiably criticizes some of Jeans's interpretations of the stability theory; but it should be more widely known that, for reasons other than Lyttleton's, Jeans himself rejected the fission theory of binary stars ("Universe Around Us" (fourth ed., Cambridge, 1944); pp. 227–235).

Dr. Lyttleton's book is clearly going to be the standard work on a subject that must form the basis for future investigations which can be expected to be of great significance.

W. H. McCrea

WRITING FOR ENGINEERS

Engineers as Writers

Growth of a Literature. Edited with Introductions and Critical Comments by Walter J. Miller and Leo E. A. Saidla. Pp. xii + 340. (New York and Toronto: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953.) 32*s*. net.

THE reviewer naturally turns with special interest to the last section of this book, entitled "Suggestions for Review of this Book", only to discover that the word is used with the common American meaning of 'second view'—what the English student would call 'revision'. This little disappointment serves to emphasize the basically American outlook of the compilers of this volume, which is a collection of reports, lectures, papers and extracts from books, all written by engineers. Three of the pieces selected are American translations of Latin authors (Frontinus, Vitruvius and Agricola), four of them are from English engineers of the eighteenth and nineteenth centuries (Smeaton, McAdam, Rankine and Parsons), while the remaining eight selections are by Americans (from Wellington, the railway economist, to Ammann, designer of the George Washington Bridge). Even with the earlier work, there is a striking contrast between the English and American idiom, which becomes progressively more marked.

It is generally acknowledged that every effort should be made to train engineering students in clear self-expression, and this collection has been made as an attempt to assist in attaining this object. As the book is intended for class use in engineering schools, the authors have made comments with each chapter and have added suggestions for study and some introductory remarks. Literary criticism of some of the selections included is disarmed by the fact that the authors themselves adopt the attitude that "any study of engineers as writers would be valueless if we did not consider their weaknesses along with their strengths".

The authors have clearly devoted much labour to the selection of their material, as is evidenced by the acknowledgments to no fewer than fifty individuals who have assisted in the undertaking. The result is an undoubtedly interesting collection of items, which it would be inconvenient (though perhaps a valuable experience) for the student himself to extract from the library shelves, were he merely given instead adequate references to each of them. Unfortunately, library facilities would be overwhelmed if an attempt were made to adopt such a scheme in class.

The most serious doubt which comes to mind, on reading this book, is whether the study of such a heterogeneous collection is, in fact, likely to assist a student to clearer, and hence better, writing of his own. Surely the approach most likely to be successful consists of an exhaustive analysis of the methods available for organizing and presenting material, followed by the most thorough criticism of his own efforts at writing and plenty of practice. But there is no reason why a book such as this might not, with some students, act as a stimulus to better writing.

R. H. Macmillan

SOCIAL INSECTS

The Social Insects

By Dr. O. W. Richards. Pp. 219 + 51 plates. (London: Macdonald and Co. (Publishers), Ltd., 1953.) 15*s*. net.

THE need for an authoritative, up-to-date account of the behaviour of social insects in general has become increasingly apparent in recent years, during which the study of the social insects has attracted much attention.

As Prof. Richards himself points out at the beginning of his book, it is to-day quite impossible for any one worker to have made personal observation on all the species of social insects or to have seen all the

varieties of behaviour which have been recorded; but it is doubtful whether there is any entomologist better qualified to write on this subject than Prof. Richards. This book will certainly be welcomed by all who are interested in the subject as it brings together in a most readable form the results of many of the more recent investigations on the biology of ants, bees, wasps and termites by workers in various countries.

After dealing briefly with such matters as instinctive behaviour, learning and orientation, the author goes on to discuss, in the first chapter, the probable way in which insect social behaviour evolved from the solitary behaviour exhibited by most insects, through various sub-social stages such as those shown by the common earwig, some dung beetles, bees and wasps, to the elaborate social behaviour of ants, honeybees, termites and some wasps.

In subsequent chapters many aspects of the behaviour of solitary and social wasps, of solitary and social bees, including humble bees and stingless bees as well as honeybees, and of both ants and termites are described. In a most valuable chapter dealing with social parasites the author expounds theories of the origin of the cuckoo bees and wasps which to-day do not possess any worker castes, and also discusses the development of cuckoo habits in ants, which exhibit all sorts of stages in the development of such behaviour, ending up in workerless, degenerate parasites.

When writing of the termites Prof. Richards stresses the fact that, although they show certain remarkable analogies with other social insects, in reality the differences between the termites and all other social insects are profound and more important than the resemblances. He traces the peculiarities of the termites to two basic facts about their societies. First, that males and females are represented at all stages and in all castes, this being associated with a different method of sex-determination; and, second, that development is gradual, over a series of moults, with no helpless grub-stage. Thus their whole caste system is much more flexible and complicated.

In a most stimulating final chapter the author discusses some of the problems which social animals have had to overcome during the course of their evolution.

This is certainly a book which can be recommended unreservedly to all students of animal behaviour, one's only regret being that it is not longer.

C. G. Butler

SOCIAL LIFE AND PHILOSOPHY OF ABORIGINES

The World of Primitive Man

By Paul Radin. (Life of Science Library No. 26.) Pp. xi+370. (New York: Henry Schuman, Inc., 1953.) 5 dollars.

ALTHOUGH this book contains many original, and often profound, observations on the mind and customs of primitive man, it suffers from the lack of an exact definition of the material studied. The author attempts, we are told, "to portray the civilizations of primitive peoples and the world in which they lived". The use of the past tense here is confusing, for most of the examples given are of present-day tribes and the world in which they are living to-day, contaminated as they have been by Western civilization. The words "primitive" and "aboriginal" are used interchangeably (as well as "civilization" and "culture", a synonym with which many would quarrel). The dictionary defines aboriginal as "indigenous, existing in a land at the dawn of history, or before the arrival of colonists", and the author accepts most African tribes as aboriginal only with "many provisos" for this very reason, because they have been transformed by colonists and invaders. Since most of the material is drawn from contemporary sources (largely the New World), this proviso should, strictly speaking, apply to nearly all of it. If it is an attempt to portray the world in which they lived in the past, this is another matter; but in this case, most of the material would be irrelevant.

There is throughout a rather subjective bias towards the "positive achievements" that "aboriginal philosophers and theorists have made to the history of thought"; the "negative" side (by which is implied magic, and the role of fear) is not stressed. These practices and emotions, the author concludes (contrary to most social anthropologists), "interfere little with the orderly processes of life and do not hinder rational and objective thinking". Taboos, for example, are often winked at, or got round, and examples are given to prove the point. But again, the examples are of present-day tribes, who have had contact with Western civilizations: it is the world in which they are living rather than have lived.

Aboriginal philosophy is summarized as "do what you like, but face the consequences", for every individual has the right not only to the irreducible economic minimum, but also to self-expression and the freedom of movement. The "consequences" may be social ostracism, but imprisonment is an uncommon form of punishment. A murderer is seldom sentenced to death, for death meant an economic weakening of the community and, as such, demanded not simply revenge but also replacement for loss with damages. Law, authority and property are never static, but circulate. The authority of an individual (the author contends) is largely fictitious or symbolic; there is seldom despotism, for power resides in the group. Status is never inherited, it is conferred at puberty, and therefore infanticide is not a crime; on the death of an individual, status or authority reverts to the group and has to be conferred again on another individual by the group. Customs only become law in emergencies, and are not obeyed because of a rigid tradition but only from the conviction that they have worked in the case of the elders. Personal property is reduced to a minimum, and anything above this is kept in compulsory movement; its value becomes enhanced as it passes from one person to the next and, although the owner sees no profit, he gains in prestige by these transactions.

One is left with a rosy picture of the happy savage enjoying "an amazing degree of social and political integration" and "the concept of personal security which transcends all governmental forms and all tribal and group interests and conflicts". In spite of the uncomfortable feeling that this picture is particular rather than general, however, one is also left stimulated, and with a better understanding of the minds of men with different cultures from our own.

Sonia Cole

Principles of Numerical Analysis

By Alston S. Householder. (International Series in Pure and Applied Mathematics.) Pp. xi+274. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 48*s*.

THIS book is not a manual on numerical computation but gives an account of the mathematical principles upon which numerical techniques covering a wide field may be based. It has been written on the assumption that the reader has access to a high-speed digital computor; but techniques for use on hand machines are also treated.

After an introductory chapter, mostly on the estimation of error, methods are described for solving systems of linear equations. The necessary matrix and determinant theory is developed *ab initio*, and is readable by the student who has gone only as far as the calculus in his mathematical training. Next, processes are described for solving non-linear equations. A thorough treatment of iterative methods is included. There is an important chapter on methods for calculating the latent roots and vectors of matrices, and for the inversion of matrices. Some new methods are described and compared with older techniques. The next two chapters deal with interpolation, and with more general methods of approximation. Then there is a chapter on numerical integration and differentiation, and finally a brief chapter—too brief, perhaps—on the Monte Carlo method.

There are some pleasing features about this book. Bibliographical notes appear at the end of each chapter, and the literature is well covered by the extensive bibliography at the end of the book. It is very easy for the reader to find a reference to more detail on any particular item of interest. The material is up to date (1952), and some recent developments have not been noted by the reviewer in any other book. Altogether, the author has been careful in the selection of material and in the method of presentation.

L. S. Goddard

Physical Chemistry of Metals

By Dr. Lawrence S. Darken and Dr. Robert W. Gurry, with a Collection of Problems by Dr. Michael B. Bever. (Metallurgy and Metallurgical Engineering Series.) Pp. ix+535. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 61*s*.

METALLOGRAPHY has been defined as the physical chemistry of the metallic state. In Britain, however, during the past fifteen years or so, attention has, in the main, been directed rather to the somewhat speculative physical aspects of the subject, though an outstanding exception is to be found in the work of Hume-Rothery and his pupils, of which generous acknowledgment is made in this book. In America, however, and by Masing in Germany, the physico-chemical aspects have remained a subject of continued study.

It is probably true that physical chemistry may be studied just as profitably in the melting furnace or heat-treatment plant as in laboratory glassware. Reaction kinetics and the theory of diffusion are examples of this. As metallurgy is being transformed from a craft to a science, although the craft is most emphatically still there, the physico-chemical bases of metallurgical processes, no less than those of metallography itself, are assuming greater and greater importance. It is therefore not without significance that both the authors of this book are connected with the United States Steel Corporation, and the volume which they have produced is one of quite outstanding interest. It should, however, be made clear from the very start that this is no 'technical' treatise. It provides a thoroughly sound treatment of general physical chemistry on classical lines, but in which the various aspects of that science are studied and exemplified from metallurgical and metallographic examples. Although it is primarily intended for the more advanced student of metallurgy, this book might be used with advantage in the teaching in university schools of chemistry. It would, at any rate, introduce a sense of realism in its own branch of that subject which at times is somewhat lacking. The success or otherwise of such an experiment would be a matter of no little interest in the teaching of pure science.

As examples of the sort of treatment adopted, the nucleation of gas bubbles may be cited, which is exemplified by the frothing of the slag in the open-hearth furnace, or that of solid diffusion, where the processes of gas-carburization and welding are similarly employed. The iron–nitrogen and the iron–carbon systems are both considered in detail as examples of particular binary systems; but one of the most interesting chapters in the whole book is that on the liquid state, which might be read with as much profit by the chemist or the physicist. This is metallurgy as a legitimate branch of science in its own right.

F. C. Thompson

Plant Life in Malaya

By Prof. R. E. Holttum. Pp. viii+254. (London: Longmans, Green and Co., Ltd., 1954.) 18*s*. net.

PROF. R. E. HOLTTUM, with some thirty-odd years of personal observations in one of the world's richest and most interesting floristic regions, has placed botanists, both in Malaya and elsewhere, in his debt by the production of this modest but fascinating volume. Into two hundred and fifty pages he has compressed an introductory account of a very complex and diverse subject—plant life in Malaya.

The aim of the book was to select judiciously from a vast amount of material, so that residents, teachers and first-year university students may be introduced on easy terms to some of the more common plants and their structure and mode of life, to species which illustrate growth-forms, the relationships of plants to their environment, floral structure, the biology of fruits and seeds, and so on. These are illustrated by line-drawings and by a wealth of what is evidently the author's personal observation. For the reviewer, at least, an attractive and interesting feature of the book is the author's demonstration of how well such common tropical plants as rubber, coconut, ginger, bamboo and yams, to mention only a few, can be used in teaching some of the elementary lessons in botany.

The curiosities of plant life, in which the region abounds—including saprophytes, parasites, aquatic plants, ant-plants, nest-ferns, climbing ferns, etc.—are also described and illustrated. In the final chapter, the author seizes on a theme that seldom fails to touch the imagination, namely, the tropical forest in all its extravagance and diversity, as a community of interdependent organisms. The effects of destroying extensive forest areas in the interests of agriculture are also expounded and discussed. This compact volume might well be used as part of the general reading of students of botany in British universities.

C. W. Wardlaw

DEVELOPMENT OF LOGICAL AND MATHEMATICAL CONCEPTS: PIAGET'S RECENT PSYCHOLOGICAL STUDIES

By Dr. W. MAYS
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JEAN PIAGET'S reputation as a psychologist in Great Britain is largely based upon a series of books written during 1925–32 dealing with the development of thought, language and moral judgment in the child. But, as he himself points out, this work was merely a prolegomena to his later investigations extending from 1937 to the present day, and reported on in sixteen books and numerous articles. But though these researches are both theoretically and experimentally an advance upon his earlier work, they have, however, had little effect on English psychological thought. (Prof. L. S. Hearnshaw, in his presidential address to Section J of the British Association, 1954, directs attention to the comparative neglect of Piaget's more recent investigations by British and American psychologists.) This is probably due to Piaget's introduction of a new and complex terminology, his use of symbolic logic, and the fact that his most important work remains untranslated. Further, these studies deal with a field which in the past has been the natural preserve of the philosopher and methodologist of science.

A. Piaget's Early Work on Child Thought and Logic[1]

Piaget (now professor of psychology in the Universities of Paris and Geneva) largely concerns himself in this work with investigating the various kinds of thought activity entering into the intellectual behaviour of the child. He criticizes the method of intelligence testing as a tool for investigating child thought, since (*a*) the test-questions and test-conditions under which the test is given are stereotyped in character, and (*b*) the use of a fixed questionnaire neglects the spontaneous answers of the child. Piaget's method in some ways resembles that of the clinical psychologist, since he attempts to make the child talk freely, varying the questions according to the situation.

Piaget distinguishes between ego-centric thought, and communicable thought depending on demonstration. In the former, in which the child uses thought largely as a means for satisfying his desires rather than convincing others, little value is attached to proof. Thought on this level is largely intuitive and operates through subjective schemata. Up to about the age of 7–8, children's concepts have a certain fluidity about them and vary imperceptibly throughout a reasoning process. The child tends to argue from particular to particular and has difficulty in coping with syllogistic and analytic reasoning. Piaget further demonstrates that the conceptual apparatus by which the child orders the world around him is of a much more naïve variety than had previously been suspected.

B. Experiments on the Development of Logical and Mathematical Concepts[2]

Starting from these earlier studies, Piaget set out to make a more detailed experimental study of the way logical and mathematical concepts develop in the child. What is really important about Piaget's approach is that it gives us for the first time a method of testing experimentally many of the concepts and principles which philosophers have discussed in the past on a purely *a priori* level.

Piaget's subjects were children aged 4–12, observed individually. The experimenter performs in front of them experiments on familiar objects (beads, counters, modelling clay, dolls, etc.) and they are asked to predict their outcome. Further questions are put to them to find out how they interpret these experiments.

(1) *The development of the concepts of quantity, weight and volume*[3]. The concept of quantity has for Piaget essentially a logical character. An example of the type of experiment used by him to study its development is given below.

Two identical vessels, A_1 and A_2, are filled to the same level with a coloured liquid. Half of the contents of A_2 are then poured into a vessel B_1 and the other half into a vessel B_2 (both the same size as A_2). The child is then asked if the quantity of liquid in A_1, and that in B_1 and B_2, remain the same. Young children of about 4–6 assert that the quantities are now unequal; some note that the levels of B_1 and B_2 are lower than that of A_1, while others, who note that the liquid is now contained in two vessels, believe that B_1 and B_2 contain together more than A_1.

The child only arrives at the concept of conservation of quantity when he knows how to restore the original state of the liquid by pouring the contents of B_1 and B_2 back into A_2. He is now able to grasp that the diminution in the height of the level of the liquid is compensated by an increase in the number of containers. For Piaget, 'reversibility', namely, the ability to produce in thought for any set of activities a corresponding reverse procedure, is essential for any form of mental experimentation as well as logical inference.

Other experiments of this series use different types of material, such as balls of clay moulded into different shapes and collections of beads. Piaget also demonstrates that the related concepts of weight and volume which appear at about 9–11 and 11–12 on the average are only acquired after the concept of quantity has been formed at about 7–8.

(2) *The development of the concept of number*[4]. In these experiments the child is required to establish a term-to-term correspondence between different collections of objects (for example, flowers to vases, glasses to bottles, counters or beads to one another, etc.).

When, for example, a child aged 4–5 is asked to spread out on a table as many red counters as there are in a row of blue counters, he begins by making a row of the same length, using only perceptual criteria. However, if the counters forming one of the two rows are spaced out or closed up a little, he will now believe that the longer row contains more. Number and space are as yet undifferentiated for him, they form a perceptual whole.

But once the concept of the conservation of number has been formed at about 7 years of age, if the intervals of the row are now changed, the child

will assert that there has been no change in number. He becomes aware (at least intuitively) that the increase of the length of the row is proportional to the increase of the intervals between the counters, and that re-establishing the original intervals re-establishes the original length of the row. He will be able to match counter to counter and thus demonstrate that the rows are equal.

Piaget believes that his experiments have some relevance to the dispute among mathematicians as to whether number is a primitive intuition or a purely logical notion. He finds that it is difficult to speak of the intuition of an integer before the child's logical concepts of invariance have developed at about 7. Further, the transition to number occurs in the child just when the classifying and ordering activities he uses about objects become related into logical systems. There is thus some resemblance between the way number comes to be constructed in child thought, and the attempt, on a purely normative plane by Russell and others, to define number in logical terms.

(3) *The development of the concepts of time, movement and speed*[5]. The concept of time, far from being an object of *a priori* intuition as the Kantians assumed, also arises at a relatively late stage, since time at first remains confused with space. Piaget demonstrates this by a further series of experiments.

For example, equal quantities of water are allowed to run into two differently shaped vessels (one pear-shaped and the other spherical). Now, despite the fact that the child has observed that the vessels have started and completed filling at the same time, he will assert that, since the level of the water in the pear-shaped vessel appears higher than the other, it has taken longer to fill. Time in this case will only be estimated objectively when the child no longer judges it simply by the increase in the level of the water, but by its increase in relation to the dimensions of the vessel.

Our everyday notion of time is also constructed on similar lines. At first the child confuses the notion of age with that of height or other visible signs of ageing. Age differences are not thought of as constants. A child born at a later date than another may outpace him if he outgrows the latter. Objective time, since it involves the ability to reverse the course of events in thought, also assumes the concept of reversibility.

As time has a complex character, Piaget, acting on a suggestion of Einstein, proceeds to study the more concrete notions of movement and speed, since psychologically they are prior to the notions of time and space. He finds that these concepts, too, are not given as primitive intuitions, but only gradually disengage themselves from perceptual experience. The speed of an object, for example, remains at first confused with the distance run through.

(4) *The development of metric, projective and topological space*[6]. Historically, geometry has developed in several stages. First there arose three-dimensional Euclidean geometry, later projective geometry and finally topology. The development of the concept of space is, Piaget claims, made in the child in precisely the reverse order. The child starts with purely topological notions, continues with projective notions and finally arrives at those dealing with the size and shape of the object. At the age of three the child can, for example, distinguish between open and closed figures. He can do this before he can draw a rectangle and express its Euclidean characteristics (number of sides, angles, etc.). Only at about 7 does the concept of perspective appear, and at about the same time the system of horizontal and vertical axes, the development of which leads to the metric representation of space. Thus the psychological order of development would seem to come much closer to modern geometry's logical order of axiomatic construction than it does to the historical order of discovery.

C. Related Studies

In discussing the concept of chance[7], Piaget makes the point that the child is oblivious to this concept as long as he remains incapable of reversible logical operations, that is, until about 7–8. There would thus appear to be a close correlation between the construction of the notion of probability and the development of logical operations. This was already noted by Boole in a somewhat different context when he linked probability with the algebra of logic.

So far as perception is concerned, there is a radical difference between Piaget's views and that of the Gestalt psychologist. For the latter the perceptual constancies of shape and size belong directly to the perceived object and are independent of age and ability. For Piaget, on the other hand, our perception of figures is built up as a result of a series of random eye and other muscular movements which are gradually corrected. Starting from the observable facts of child behaviour, Piaget's work would seem to reinforce some of the conclusions of the cybernetician, since he believes that the logical systems which emerge in child behaviour arise as a result of the child's trial and error activities attaining an *equilibrium*. Piaget is also interested in the neuro-physiological aspects of thought activity. He believes that, with the aid of logical techniques, it may be possible to translate the child's activities of classifying, ordering, setting up correspondences, etc., into neuro-physiological terms.

The most interesting conclusion which emerges from this important series of experimental researches[8] is that mathematical concepts in their psychological development are ultimately based upon simple logical notions. Indeed, it might be said, without undue exaggeration, that Piaget's psychological studies are the genetic counterpart of Russell and Whitehead's attempt in "Principia Mathematica" to put mathematics on to a logical basis.

[1] "The Language and Thought of the Child" (1924). "Judgment and Reasoning in the Child" (1924). "The Child's Conception of the World" (1926). "The Child's Conception of Causality" (1927). "The Moral Judgment of the Child" (1932). (All published by Routledge.)

[2] Summaries of Piaget's more recent work may be found in "Introduction à l'Épistémologie Génétique" (Presses Universitaires de France, 1949–50, 3 vols.); and "Logic and Psychology" (Manchester University Press, 1953).

[3] "Le développement des quantités chez l'enfant" (Delachaux et Niestlé, 1941).

[4] "La genèse du nombre chez l'enfant" (Delachaux et Niestlé, 1941. English translation, Routledge, 1952).

[5] "La développement de la notion du temps chez l'enfant" (1946); "Les notions de mouvement et de vitesse chez l'enfant" (1946). (Both published by Presses Universitaires de France.)

[6] "La représentation de l'espace chez l'enfant" (1948). "La géométrie spontanée chez l'enfant" (1948). (Both published by Presses Universitaires de France.)

[7] "La genèse de l'idée de hazard chez l'enfant" (Presses Universitaires de France, 1951).

[8] Other recent works of Piaget are: "La naissance de l'intelligence chez l'enfant" (1937; Eng. trans. 1952); "La construction du réel chez l'enfant" (1937); "La formation du symbole chez l'enfant" (1945; Eng. trans. 1951); "La Psychologie de l'Intelligence" (1947; Eng. trans. 1950). The logical aspects of his work are treated in "Classes, Relations et Nombres" (1942); "Traité de Logique" (1949); "Essai sur les transformations des opérations logiques" (1952). For Piaget's recent articles see *Archives de Psychologie*.

GERMANIUM AND GALLIUM AND THEIR APPLICATIONS

ON September 7, three papers on germanium and gallium were read before Section B (Chemistry) of the British Association. Mr. A. R. Powell gave an account of the occurrence of germanium and gallium in British minerals and their extraction from flue dust, Mr. A. A. Smales discussed problems in the analysis of the raw materials and finished products, and Dr. E. G. James described the scientific and industrial applications of germanium.

Germanium occurs in Britain in the zinc ores of North Wales, the pure zinc blende often containing up to 0·03 per cent of the element; but the quantity of ore mined is insufficient to justify special treatment for the recovery of its germanium content. Germanium and gallium are trace constituents of most coals mined in Britain, except those of Kent and the South Wales anthracites. The amount present varies considerably from a few up to 30 p.p.m., with an average of about 7 p.p.m. This means that more than 1,000 tons of each element are present in the coal mined every year in Britain. But only a very small proportion of this output can be recovered economically. When the coal is burned in domestic grates and industrial furnaces, the soot or flue-dust produced contains only insignificant concentrations of germanium, most remaining with the ash. In the smelting of iron ores the germanium in the fuel passes mostly into the pig iron and then is lost in the slag or fume produced in the open-hearth or Bessemer refining processes. In the coking of coal practically all the germanium and gallium remain with the coke; but here again they are lost when the coke is used for domestic or industrial heating. However, when the coke is converted into producer gas, the sulphur present is sufficient to convert both the rare elements into their volatile lower sulphides, which pass off with the producer gas; on cooling this gas the soot deposited may contain up to 0·5 per cent of each rare element as well as up to 50 per cent of carbon and a large number of other elements. This gas is, however, usually burned while still hot, and then the rare elements are converted into their non-volatile higher oxides which collect in the flue system. In the gasworks much of the producer gas made is used for heating the coking retorts, and the heat of the waste gases from this operation is utilized in waste-heat boilers before the gases pass to the stack. The dusts, which collect in the flues between the boilers and the stack, are at present the principal sources of germanium and gallium in Britain. The amount of the rare elements in the dust varies from almost nothing up to as much as 2·7 per cent, according to the conditions under which the producer is operated and the gases are utilized; the average content of gasworks flue dust is, however, 0·5–0·7 per cent of each of the rare elements. If the coke is used for making water gas, the conditions in the producer are so strongly reducing, owing to the high hydrogen content of the gas, that the volatile compounds of the rare elements are converted into metal which alloys with the common metals, chiefly iron, present in the reduced ash of the coke; consequently, no germanium or gallium is found in the flue dust from burning water gas.

The high affinity of germanium for iron and of gallium for copper is made the basis of the first step in the extraction process. Dust from many gasworks is mixed and analysed, and a charge is made up of dust, fluxes, coke and copper-bearing materials such that, on smelting, a neutral silicate slag is obtained together with a metallic regulus consisting of iron, copper, sulphur and arsenic with which most of the germanium and gallium are alloyed. A small proportion of the rare elements passes into the zinc fume which is evolved during smelting and is recovered from the zinc oxide flue dust which collects in the baghouse. The metallic regulus is broken up and placed on a perforated plate in a large glass tower filled with dilute ferric chloride solution through which a current of chlorine is passed. The resulting exothermic reaction heats the solution to boiling and maintains it in this state until all the regulus is dissolved, loss of volatile constituents being prevented by a reflux condenser at the top of the tower. The concentrated chloride liquor from the towers is transferred to glass stills, treated with sulphuric acid to liberate 6 *N* hydrochloric acid, and distilled to remove arsenic trichloride and germanium tetrachloride with the hydrochloric acid vapours. The condensate separates into two layers, the upper consisting of 6 *N* hydrochloric acid containing most of the arsenic chloride and the lower of germanium tetrachloride with 10–15 per cent of arsenic trichloride.

The lower layer is separated and fractionated in an adiabatic column similar to that used in the separation of hydrocarbons in the oil industry. This yields an overhead of germanium tetrachloride containing about 10 p.p.m. of arsenic and a residue of arsenic trichloride almost free from germanium. The distillate is refluxed over copper turnings for some hours and again distilled to yield a distillate with less than 0·05 p.p.m. of arsenic based on its germanium content, the arsenic trichloride present in the fractionated chloride having been converted by the copper into non-volatile copper arsenide and cuprous chloride. The pure germanium tetrachloride is stirred for some hours with sufficient water to hydrolyse it and leave a 6 *N* hydrochloric acid solution in which the solubility of germanium dioxide is a minimum.

The resulting oxide is collected, washed free from acid, dried at 150° C., and reduced to germanium powder by heating in a rapid current of hydrogen at 650° C.; the powder is then melted in nitrogen or inert gas to obtain an ingot of germanium containing no chemically detectable impurity other than about 0·05 p.p.m. of arsenic. This product is, however, not sufficiently pure for the physicist who, therefore, further refines it by zone melting. In this process a series of molten zones is caused to travel along the ingot so as to collect the impurities and sweep them along to one end. In this way practically all the impurity collects at one end of the ingot, the remainder of which is left in a highly pure form.

Gallium is recovered from the liquid remaining in the stills from which the crude germanium chloride was distilled, by first reducing the ferric salt to ferrous and precipitating the copper, arsenic, antimony and heavy metals by stirring with scrap aluminium. The acidity of the reduced solution is then adjusted to 6 *N* by adding hydrochloric acid, and the gallium chloride removed by continuously distilling *iso*propyl ether into the bottom of the vessel containing the stirred solution and allowing the ether to overflow from the top of the vessel back into the ether distillation flask. In this way gallium chloride accumulates in the aqueous layer below the ether in the

latter flask. This layer is freed from ether and treated with hydrogen sulphide to remove traces of heavy metals. The purified solution is then made alkaline with sodium hydroxide, filtered, and electrolysed to recover the gallium, which is finally purified by shaking with nitric acid.

So far, little commercial use has been made of gallium; but it has some interesting properties which may in the future find industrial applications. It melts at about 30° C. and boils at above 2,000° C.; but unfortunately the liquid metal attacks at high temperatures all metallic materials of construction now known and reacts with most refractory materials unless completely protected from oxidation; it can, however, be handled in silica ware up to above 1,000° C. in absence of oxygen.

The chief analytical problems associated with germanium and gallium are their determination in ores and coals and the determination of impurities in the purified elements. Traces of gallium can be completely extracted as the oxinate from solutions of *p*H 2–3 by chloroform and afterwards determined by measuring the fluorescence of the morin compound. Traces of germanium are best recovered by distillation of the chloride or extracting it with carbon tetrachloride; the element can then be determined colorimetrically in the spectrophotometer as the phenylfluorone complex. For the determination of arsenic in germanium oxide or metal chemically, a complex of germanium with oxalic acid must first be prepared; the arsenic can then be extracted by addition of diethylamine diethyldithiocarbamate and shaking with chloroform. The extracted arsenic can be determined spectrophotometrically as the reduced arsenomolybdate complex, or by a modification of the Gutzeit test in which electrolytic hydrogen from a zinc-coated platinum cathode is generated in the solution and then passed over thin cotton string impregnated with mercuric chloride to collect the arsine; the stain is developed by immersion in silver nitrate solution and its length is measured and compared with that of similar stains produced from known amounts of arsenic. The success of both of these methods depends on the absolute freedom of the reagents from arsenic, but of course blanks must be used to correct for traces of arsenic in the reagents. The radioactivation method developed recently at Harwell is designed to overcome this disadvantage; in this method the substance is placed in the pile to convert the inactive arsenic-75 into active arsenic-76, a known amount of inactive arsenic (say 50 mgm.) is added and, after ensuring thorough mixing, the arsenic in the mixture is extracted and determined by any suitable chemical method. The amount of radioactive arsenic is then determined by counting and, since the proportion of the arsenic recovered to arsenic added is known, a simple calculation gives the arsenic in the original material; in this way as little as 10^{-10} parts of arsenic may be estimated with accuracy compared with 2×10^{-8} by chemical methods using a much larger sample.

Very pure germanium is of great importance to the physicist, since it enables him to investigate fundamental processes such as electrical conduction and wave-motion in solids; but the importance of germanium to the electronic engineer depends on the presence of very minute quantities of certain impurities. Germanium free from all impurities would have the relatively high resistivity of 70 ohm-cm. at room temperature, since most of its valence electrons are tightly bound in interatomic bonds leaving very few to conduct current. On replacement of a few germanium atoms in a crystal by arsenic, four of the valence electrons of arsenic form bonds with neighbouring germanium atoms and the fifth becomes free to increase the conductivity of the crystal; such germanium is known as '*n*-type' since the current is carried by negative electrons.

On replacing some of the germanium atoms in a crystal by tervalent atoms such as indium, gallium or boron, only three of the four interatomic bonds are filled, and the fourth has a missing electron; the resulting hole behaves as a localized positive charge. The impurity atoms will take an electron from a neighbouring bond in the lattice and the hole is set free to contribute to the conductivity; germanium in which the principal mode of conduction is by holes is known as '*p*-type'. Rectifying devices have been made from both *p*- and *n*-type germanium and from a combination of both. Generally, the impurity concentration required is very small (10^{-7} to 10^{-9}) and has to be controlled within fine limits if devices with reproducible characteristics are to be produced.

Since germanium is very prone to twin, and twinned crystals are undesirable in rectifying devices, the zone-purified ingot must be converted into a single-crystal ingot. For this purpose the germanium is melted in a crucible and a small seed of single crystal is immersed in the top of the molten germanium, which is then made to solidify on to the seed while the growing crystal is withdrawn very slowly from the melt. The required impurity content is added to the melt before growing the single crystal. The resulting single crystal is cut up into thin slices, which for point-contact devices are cut into sections 1 mm. square and $\frac{1}{2}$ mm. thick. This is attached to a backing, and a fine tungsten wire is arranged to make contact with the face of the germanium under slight pressure. With such a device the current increases rapidly when the whisker is positive with respect to the germanium, but the current is very small when the whisker is negative, up to the turn-over voltage, usually well above 100 volts.

The next device to be developed was the point-contact triode, which was the first semi-conductor amplifier. This device consists of a small wafer of *n*-type germanium, one face of which is soldered to a metal support, while at the other face two fine metal wires make point contacts at a distance apart of less than 0·005 in. If one whisker is biased negatively and the other positively with respect to the base, the device behaves as an amplifier with characteristics similar to those of a thermionic triode. These devices have important applications in computors and oscillators, since the rate of change of collector current with emitter current is about 3. Triodes capable of oscillation at frequencies approaching 100 Mc./sec. have now been developed.

More recently, *p–n* junction diodes and triodes have been prepared by diffusing indium and antimony or arsenic into the germanium in such a way that one portion of the crystal is *p*-type and the other *n*-type, or a central thin portion of *p*- or *n*-type separates two outer portions of *n*- or *p*-type respectively. Various methods of producing such crystals were described and some of their characteristics illustrated by graphs. Among the important features of these devices are small size, ruggedness, low voltage operation, low power consumption and long life. They suffer, however, from the disadvantages that they are not suitable for operation above about

60° C., and the maximum frequency of operation of triodes is at present limited to 1–2 Mc./sec. Experimental types have, however, been prepared capable of operating up to about 20 Mc./sec. as amplifiers and up to 100 Mc./sec. as oscillators. The first application of these devices to reach commercial production is as a hearing-aid amplifier; but some of the most important applications are likely to be in the telecommunications field, domestic radio and electronic computors. At present the biggest problem with computors is dissipation of the heat generated by the large number of thermionic valves employed. Crystal valves not only remove this handicap but also one triode can be made to do the work of two thermionic valves, thereby simplifying the circuit.

A. R. Powell.

THE RELIEF OF PAIN

In his presidential address to Section I (Physiology) of the British Association meeting at Oxford, which opened a morning's discussion, Prof. A. D. Macdonald, University of Manchester, stressed the importance of the relief of pain even though chemotherapy now deals so efficiently with the causal organisms of many diseases. When the Section last devoted a day to the problems of pain—in 1939—relief was largely limited to the use of opiates and the rather heroic destruction of pain pathways by surgery or alcohol injections. Since then new synthetic analgesics have been developed along various lines. These drugs have their advantages and disadvantages, and the establishment of their analgesic value in the laboratory is only a first step in the assessment of their clinical possibilities.

Analgesics can be defined as drugs which reduce or relieve the sensation of pain without producing loss of consciousness or parallel depression of other senses. Thus general anæsthetics, while used at times, as in labour in sub-anæsthetic doses, for escape from pain, are not true analgesics nor are they desirable in the everyday treatment of pain. Local anæsthetics are of established value in the treatment of certain localized pains, such as fibrositis, and can give remarkable and sustained relief in suitable cases. The use of this group intravenously for analgesic purposes, though supported by some, is difficult to justify pharmacologically, for most local anæsthetics are rapidly cleared from the blood-stream and their use is not free from the danger of depression of the respiratory centre.

Adrian, while doubting whether pain is as much appreciated at the level of the thalamus as Head maintains, agreed that the basal ganglion and the cortex share in its experience. True analgesics should therefore act at both levels. Tracer technique has not so far indicated marked selective action in these areas. Local application of analgesics to the mid-brain is effective with very small doses; but the precise mechanism of analgesic action is still unknown and does not appear to be due to changes in oxygen consumption.

Prof. Macdonald dealt with methods for the comparative assessment of analgesic drugs in both experimental animals and in man, stressing the large psychological element and the substantial individual variation in such experiments. The need in new analgesics is not so much for substances more potent than opium and its alkaloids or the modifications thereof in therapeutic use, for these are powerful enough. What is wanted is a drug with all the advantages of morphine and none of its disadvantages, and work to this end has followed on various lines, of which the following have been most promising:

(1) Drugs closely related to morphine, of which levorphan is one of the best, while dextromethorphan is interesting because it allays cough in small doses though not analgesic and apparently not a drug of addiction.

(2) Pethidine and related compounds, now widely and successfully used to reduce pain during labour, together with inhalations of nitrous oxide or trichloroethylene.

(3) Methadone and related compounds, which are in the morphine class as analgesics though less effective as narcotics and in the relief of anxiety.

(4) The dithienylbutenylamines, intermediate in activity between pethidine and methadone, but still in the experimental stage.

All these, like morphine, are potential drugs of addiction; this limits their usefulness in chronic non-fatal illness. The potentialities of a new drug as a drug of addiction are often obscure; but there are various methods by which it can be assessed, and these methods were discussed.

The coal tar antipyretic-analgesic group (Fourneau's antalgics) has aroused new interest from the use of phenyl-butazone in the treatment of rheumatic symptoms. This drug has much in common with the now despised or rejected amidopyrine, while some new compounds promise to be more powerful yet safer.

Such drugs as the barbiturates have failed to live up to their original pretension to analgesic activity except in anæsthetic doses; for this purpose the short-acting barbiturates such as sodium thiopentone are increasingly used.

Cannabis, its active constituents and their synthetic substitutes have limited analgesic activity, and therapeutic interest in this group is now largely limited to the treatment of cannabis addiction. To restore morale and maintain confidence, methyl pentynol and chlorpromazine might be more effective. The search for the ideal drug continues, and with so many attacks on the problem a solution will surely be found.

A paper on "Some General Views on Drug Addiction" was read by Dr. P. O. Wolff, of Geneva, chief of the Section of Drugs Liable to Produce Addiction of the World Health Organization. Dr. Wolff said that by accepted definition addiction is a disease, not a crime, and that even when it leads to certain illegal acts these may be symptoms of the disease. The drug peddler, however, should be treated as a potential murderer. Again by definition, addiction differs from habit in that it produces a state of periodic or chronic intoxication detrimental both to the individual and to society. Thus barbiturates, like morphine, cocaine and cannabis resin, are potential drugs of addiction, whereas tobacco is a habit. The symptoms of addiction are the overpowering desire or need to continue the taking and obtaining of the drug by any means, the tendency to increase the dose because of the development of tolerance, and the development of psychological and sometimes physical dependence on its effects.

Addiction is distinctly a human phenomenon. While animal tests of the addictive capacity of a drug might be misleading, Seevers has confidence in his ability to make accurate predictions by his studies

on monkeys of the risks of analgesics to induce tolerance and physical dependence in man. Many attempts have been made to account for tolerance. The most satisfactory available hypothesis is still the 'dual action' developed by Tatum, Seevers and Collins, according to which the drug combines with receptors both on the surface and within the nerve cell, which acquires resistance to narcotic effects. Physical dependence denotes the presence of an acquired abnormal state wherein the regular administration of adequate amounts of a drug has, through previous prolonged use, become requisite to physiological equilibrium. The degree of physical dependence often runs parallel with the development of acquired tolerance. Dr. Wolff agreed with Prof. Macdonald that there are good prospects of the discovery of analgesics which will be free from the undesirable properties of morphine while retaining its valuable actions.

Dealing with the work of the World Health Organization on drugs of addiction, Dr. Wolff stressed the importance of an early decision on the convertibility of innocuous compounds into drugs of addiction. A drug is regarded as 'convertible' when the ease of the conversion and the yield constitute a risk to public health, or where there is still uncertainty about that risk. Up to the present, all synthetic analgesics have proved to be addiction-producing. The fact that a drug can be used for a time on many psychologically normal patients under hospital conditions without addiction arising is no guarantee of its safety—a better test is to see whether or not in addicts it could adequately replace their usual drug.

There is a widespread misconception about the prognosis in the addict. Relapse is common because former addicts often remain emotionally disturbed. Yet the high incidence of relapse does not justify a refusal to treat the sufferers any more than in other chronic diseases. There is now a combined approach from the chemical, pharmacological, clinical, mental health, sociological and legal angles, reinforced by well-established international co-operation.

Mr. J. B. Pennybacker, neurological surgeon to the Radcliffe Infirmary, Oxford, read a paper on the contribution of surgery to the relief of pain. Drugs, he maintained, are best used for pains which are not expected to last long, such as that attendant on surgical operations or manipulations. Drugs are also important in painful incurable diseases, some of which being non-fatal cause untold misery over years.

Surgery has been most successful in relieving pain due to mechanical disorders and inflammatory processes. The hope that with expanding knowledge of the anatomy and physiology of the central nervous system many of the intractable pains such as headache, backache, facial neuralgia, post-herpetic neuralgia, painful amputation stumps or phantom limbs and causalgia following peripheral nerve injuries might be relieved by the neurological surgeon has been fulfilled only in part. Increasing knowledge of the pain pathway has increased the possibility of successful relief by dividing that path, and this has been done at various levels.

Section of peripheral nerves has a limited application because most nerves have motor fibres, because of the extensive overlap in innervation, because trophic changes follow complete denervation, and because divided nerves might regenerate and the pain return. Section of posterior nerve roots avoids motor paralysis but the other drawbacks of nerve section remain. Its greatest success is in trigemial neuralgia, probably the most severe of all pains, by section of the root behind the Gasserian ganglion.

The operation of cordotomy (division of the spinothalamic tract) has been practised since 1911, and though still used has not proved the hoped-for panacea, for relief often lasts for only a few months. In other countries small focal lesions have been produced in the optic thalamus, the great sensory nucleus in the base of the brain, using stereo-tactic methods. Excision of the relevant cortical area, which subserves the highest level of sensory perception, unfortunately sacrifices a good deal of ordinary sensation as well as pain, and the pain might persist or recur. Frontal leucotomy sometimes relieves a patient's misery, and he bothers no longer about his pain—or about anything else. Smaller lesions appear justifiable in some cases, to ease the pain of the last few months of a patient's life, not only for the patient's sake but also for the relatives who have to watch and suffer as well.

Mr. Pennybacker referred to the challenge of an ageing population in which the problem of finding relief from pain is increased. He doubts whether the development of 'pain clinics' is the answer, because interest there would be focused on a symptom instead of the disease. He found the greatest encouragement for the neurological surgeon in the discovery, twenty-two years ago, of how sciatica is often due to compression of a nerve root by a rupture of the intervertebral disk. This affords a satisfactory explanation for the pain and a certain method of curing it.

In the subsequent discussion the speakers were asked about the relief of the pain of 'nervous tension' and the value of hypnotism in anæsthesia, in relieving pain and in the treatment of drug addiction. Dr. Wolff and Prof. R. R. MacIntosh expressed doubt about the efficiency of hypnotism unsupported by other measures.

THE VEHICLE AND ROAD SAFETY

THE increasing interest in the scientific attack on problems of road safety was shown by the fact that the whole of one of the opening sessions on September 2 of Section G (Engineering) at the British Association at Oxford was devoted to two papers on the safety of vehicles. The first paper was by Mr. G. Grime, of the Traffic and Safety Division of the Road Research Laboratory, and the second by Mr. D. Bastow, chief engineer, Jowett Cars, Ltd.

Mr. Grime set out to show where improvements are required in the design of vehicles, to demonstrate the urgent need for better maintenance of lights and brakes, and to consider how these improvements might be brought about.

To be able to see well is obviously of the greatest importance to a driver, and, in this connexion, startling figures were given to show the poor state of aim and maintenance of vehicle headlamps. Only about one-half of the headlamps examined in a survey carried out in 1952 were aimed within three degrees of correct aim, while one-sixth had deteriorated so badly that their light intensities were less than one-tenth of what they once were when new. All this leads to the inequalities of illumination which are the most potent factor in causing dazzle and poor seeing.

A similar situation, though not quite so disturbing, exists in regard to the brakes of vehicles in use on the

roads of Britain. A survey, made in 1948–50, revealed that about 7 per cent of vehicles require twice as great a distance to stop as that given in the Highway Code for brakes in good condition.

Mr. Grime gave reasons for concluding that the most effective way of making the necessary improvements in the maintenance of the vehicle to overcome present shortcomings in headlights, brakes, etc., is compulsory vehicle inspection. Evidence from the United States suggests that compulsory vehicle inspection and associated safety measures have resulted on the average in a 12 per cent reduction in deaths in the States where it is in force.

Comparatively small changes in the design of vehicles to improve visibility might perhaps lead to substantial reductions in accidents. The right-turning manœuvre is a dangerous one for almost all vehicles, and the fitting of properly designed and placed rear-view mirrors as standard on all vehicles including bicycles was advocated.

In emergency braking, especially on wet roads, steering control may be completely lost if both wheels on either front or rear axle lock. An efficient brake, arranged never to lock any wheel, whatever the friction between tyre and road, would therefore represent an important advance in the design of the vehicle, and would be particularly beneficial to motor-cyclists.

American research on the injuries suffered in car accidents shows that much could be done, by redesigning the interior of the car, to minimize the severity of these injuries. The most important requirements are the elimination of sharp edges and points, the fitting of resilient pads at appropriate positions, and the provision of safety belts or other means of holding the occupants in place during the accident. Mr. Grime suggested that the vulnerability of motor-cyclists to injury (about thirty times that of drivers of four-wheeled vehicles) might be reduced by enclosing their vehicles in saloon bodies and perhaps tying the riders into their vehicles with safety belts. There is already a tendency in the direction of making enclosed motor-cycles for reasons of weather protection.

Mr. Donald Bastow introduced his paper entitled "Vehicle Design for Safety" by referring to the great possibilities of reducing accidents which were afforded by improvements to the road system of Britain. An experiment by Mr. G. T. Bennett in the County of Oxford showed that, by relatively slight alterations to rural road junctions, a reduction of about one-third in the accident-rate at those junctions had resulted. There was little evidence from insurance premiums that vehicles of particular makes were more liable than others to be involved in accidents, and he considered that accidents were generally the result of human frailties rather than vehicle imperfections.

Like the previous speaker, Mr. Bastow considered that the first and most important safety requirement is all-round visibility, and proceeded to describe the methods employed in measuring and plotting the obstructions to the driver's vision. He considered that curved safety glass had done more than anything else to improve visibility, by enabling windscreen pillars to be placed farther back, and by making possible really large rear windows. Important accessories which are now coming into use on modern cars to improve visibility are windscreen-washers, powerful fresh air heating systems, and electrically heated rear-windows.

For driving in fog, Mr. Bastow advocated the use of headlamps by day to give warning of approach and by night the use of two fog lamps to give a wide spread of light.

Next in importance to visibility comes the controllability of the vehicle, and here the speaker discussed, in simplified form, modern theories of steering, stressing the all-important role of the tyre. For ease of control, particularly by inexpert drivers, an 'understeering', that is, a stable rather than an 'oversteering' or unstable characteristic, is desirable. Springing also influences controllability, and the softer front springing which has become possible with independent front springing has helped in this respect by reducing variations of load on the front wheels.

Two practical problems in maintaining efficient braking are those of adjustment and of overheating with consequent fading of brake efficiency. A new development which may overcome both is the disk brake, with which a greater mechanical advantage may be employed.

Further considerations in favour of a non-locking brake were mentioned. Such a brake is already available for aeroplanes and may eventually become a commercial possibility for road vehicles.

In the discussion which followed the two papers, Mr. L. Bainbridge-Bell mentioned a very simple and cheap brake-testing device made in the form of a rectangular box, of such a size that when placed on a flat horizontal surface in the car, it fell over when a certain deceleration was exceeded.

In reply to a question by Sir Richard Southwell, Mr. Grime gave the results of a series of tests by the Road Research Laboratory comparing yellow with white light for headlamps. Two cars and twenty drivers were employed in the tests, which took place on a track, about half a mile in length, along which unlighted obstacles were placed. The cars were fitted with both white and yellow headlamps of the same design and giving the same beam distribution. They started simultaneously from opposite ends of the track using in turn either the white or the yellow headlights. Drivers were asked to record their preferences both when the opposing car was too far away to produce dazzle and when it was near. Tests were conducted with the track both dry and wet, and with correctly and incorrectly aimed beams. In tests of a different kind, the distances at which test objects could be seen were measured, this time with six observers.

The results may be summarized in the statement that all the differences found were small. The distances at which the target could be distinguished were on the average slightly greater (about 5 per cent) with yellow than with white light, but this increase is not a significant one. In the opinion tests with twenty observers, when there was no opposing glare, there was a significant preference for the white beam. When the cars approached near one another, although more observers considered the yellow beam less glaring than the white, there was a small majority in favour of the all-white system. It may therefore be stated with confidence that changing over to yellow light will not solve the headlight problem.

Dr. E. A. Watson directed attention to Fig. 13 of the first paper, which indicates that there is more glare from the modern British dipped headlamp than from headlamps on American roads. Since modern British and American dipped beams are very similar in characteristics, the difference suggests that British headlights are not properly aimed when they leave the manufacturer or agent.

Dr. Watson deprecated the unsafe practice of driving with sidelights in badly lighted streets.

Mr. B. G. Robbins brought up the question of improved windscreen wipers with blades travelling horizontally across the glass, and Mr. Bastow said that this is quite feasible though expensive. A wiper of this type was on the market some years ago but has been abandoned.

OBITUARIES

Prof. William S. Boulton

The death on September 14 of Prof. William S. Boulton, emeritus professor of geology in the University of Birmingham, in his eighty-eighth year, has removed the last of the Victorian geologists. He was first an assistant of Lapworth's at Mason College, Birmingham, and later studied under Judd at the Royal College of Science, London, heading the examination list in geology. He stayed on for a fourth year as one of two assistants to Lockyer in his work on stellar photography, the other being Richard Gregory, later editor of *Nature*. The Victorians built on broad foundations! In 1890 Boulton returned to Mason College as demonstrator and assistant lecturer under Lapworth, and in 1897 went to University College, Cardiff, as lecturer in geology and geography, becoming professor there on the creation of the University of Wales in 1904.

Under Lapworth, engineering and mining students were taught the principles of geology, with some emphasis on their application to their particular professions, and with field-work as an essential part of the course—a novelty in those days. Boulton carried these ideas to South Wales and did a good deal of proselytizing through the medium of university extension lectures, to which he attracted large audiences, chiefly in the mining towns of the coalfield. He also was a contributor to and editor of a six-volume "Text-book of Practical Coal Mining".

At Cardiff he built up a reputation as a teacher of geology and geography, and as a consulting geologist in coal mining and water supply; and on Lapworth's retirement from Birmingham in 1913 he was appointed as his successor. The First World War interrupted all university work; but after it Boulton brought the whole of the Geology Department under one roof—it had previously been partly in the new buildings at Edgbaston and partly at Mason College—and under his guidance it expanded greatly while retaining the ideals of Lapworth with respect to pure research and the application of academic geology to engineering, mining and later to the oil industry. Boulton became acknowledged as one of the most outstanding authorities on the geological side of water supply, and he practised as a consultant for many years after his retirement from the University on reaching the age limit in 1932.

Boulton rendered public service on the Geological Survey Board, the Safety in Mines Research Board, the Government Inland Water Survey and the Council of the Geological Society; he was president of Section C (Geology) of the British Association in 1916, of the South Staffordshire and Warwickshire Institute of Mining Engineers (1922–23), vice-president of the Geological Society (1934–35) and dean of the Faculty of Science both at Cardiff and Birmingham.

Apart from his investigations in connexion with coal and ironstone mining and water supply, most of which naturally remains unpublished, Boulton's early interests were petrographical. Later he made valuable contributions to our knowledge of the red rocks between the Coal Measures and the Trias in the Midlands; but it is particularly as a teacher, administrator and consultant that Boulton will long be remembered by colleagues and by a host of students now scattered all over the world.

L. J. Wills

Prof. Antonio Minto

Prof. Antonio Minto, whose death is reported at the age of seventy-four, was for long years one of the best known and most influential figures in Italian, especially Etruscan, archæology. As professor in Florence, as 'soprintendente' for northern Etruria, and as president of the Istituto di Studi Etruschi, he came to occupy a commanding position in this field.

Born at Pieve di Sacco near Vicenza in 1880, the first part of his archæological life was spent in Greece, where he worked with Halbherr and Pernier. Then came the First World War. Afterwards he worked in Campania (1922–24), until, in 1924, he was appointed 'soprintendente' in Florence. There he remained until the end of his working career (he retired in 1951), and it is with Florence and northern Etruria that his name will always be particularly associated.

Under his direction the reorganization of the Museo Archeologico in Florence, begun in the reign of Milani, was largely completed. The original home of the Museum, the Palazzo della Crocetta, was enlarged by the addition (1930–40) of the long series of galleries that now house the greater part of the Museo Topografico, and was itself largely rearranged so that a great quantity of material was made readily available to students. The vision that had been Milani's, of Florence as the centre for Etruscan, and indeed Italic, studies, was shared by Minto, although he could never realize it fully. He had to endure the existence of another 'soprintendenza' for southern Etruria and the sight of the rich results of the new excavations at Vulci and Cervetri going to the Villa Giulia in Rome. He was, however, able to bring to birth the Istituto di Studi Etruschi with its home in Florence, and its annual, *Studi Etruschi*, published there (1927 onwards). Moreover, the extraordinarily rich collections of the Florentine museum, logically arranged and fully exhibited, together with the attitude of its directorate that makes study in the museum easy, have enabled it to maintain its position as the best single place in which to study Etruscan civilization.

Minto was not a great original scholar, not an intellect with the imagination to open up vast new vistas: his great service was in making material available and encouraging study. His work in the Museum was one result of this guiding principle. His writings, which were numerous, were nearly all publications of material that came into his control. New finds in his province were usually made known comparatively quickly and comparatively fully. His only two major publications were, characteristically, excavation reports: one of the remarkable early necropolis at Marsiliana d'Albegna excavated by the Prince Don Tommaso Corsini (published in 1921); the other of his own most important excavations, at Populonia (published in 1943). Besides these excavations, he undertook many less exciting investigations, notably at Heba, Saturnia and Sestino, of which notices appeared in the *Notizie degli Scavi*.

W. L. Brown

NEWS and VIEWS

W. C. Gorgas (1854–1920)

One of the world's greatest sanitarians, William Crawford Gorgas, was born a century ago, on October 3, 1854, near Mobile in Alabama. After graduating M.D. at Bellevue Hospital Medical School, New York, in 1879, he joined the Medical Department of the United States Army. An attack of yellow fever at Fort Brown, Texas, rendered him immune from this disease, and as a result he was frequently sent to camps where outbreaks had occurred. In 1898 he was appointed chief sanitary officer in Havana. When the Reed Commission had proved the mode of transmission of yellow fever by *Aedes aegypti*, he began to attack the mosquito's breeding places and in less than eight months succeeded in eradicating the disease from a region where it had existed continuously for one and a half centuries. But for Gorgas, the construction of the Panama Canal could never have been accomplished. Made chief sanitary officer of the Canal Zone in 1904, he converted this 'white man's grave' into a healthy and inhabitable region. His reputation was now world-wide. In 1913 he visited the Transvaal to advise on the control of pneumonia among the native miners of the Rand and afterwards investigated endemic foci of yellow fever in South America for the Rockefeller Foundation's International Health Board. During 1916–18 he served as surgeon-general of the United States Army. On his way to West Africa, he died in London on July 3, 1920, after a cerebral hæmorrhage, and was given a military funeral in St. Paul's Cathedral. During his last illness he was visited by King George V, who conferred an honorary K.C.M.G. upon him.

Second International Conference of Teachers of Geography

In 1951 the British Geographical Association initiated an international conference with a meeting at Sheffield, and in August 1954 Holland acted as host for the second conference, which was attended by 160 delegates from about twenty countries. Wisely the formal work is limited to the thorough discussion of two or three topics, each introduced by a paper and then debated in groups before the group-leaders put questions to the lecturer. In every discipline there is the constant problem: How soon and at what stage should academic advances in the subject—with results which may only be tentative—be introduced into the teaching in schools and colleges? The Conference agreed that the concept of under-developed lands contains an element of subjective judgment highly dangerous if introduced without the utmost care to children of school age. The idea of different stages in cultural and economic development is better introduced incidentally in the teaching of regions. The separation of physical and human or social geography which exists in Dutch universities was admitted as specially applicable to conditions in a country where vital work in land reclamation and soils is so much to the fore, but generally was regarded as unsuitable elsewhere. The discussion on 'field-work' revealed no exact word or phrase in the languages of Western Europe to cover the outdoor activities of school geography classes now so well known in Britain and voted as desirable elsewhere. The other half of the work of the Conference is for the host country to show in the field as much as possible of modern developments. This the Dutch, under the presidency of Dr. W. J. Jong and with Prof. A. C. de Vooys as organizing secretary, did extremely well—with special emphasis on the problems of the new polders of the erstwhile Zuyder Zee.

Vacation Course in Synoptic Meteorology

For the fifth year in succession, the Royal Meteorological Society, in conjunction with the Council for the Promotion of Field Studies, held a vacation course in elementary synoptic meteorology at the Council's field-centre at Malham Tarn. The course was held this year during August 25–September 1 and was attended by some thirty-five students. The majority of students attending were undergraduates, reading for degrees in mathematics, physics and geography, nearly half the universities in the United Kingdom being represented. The instructors were again Mr. James Paton, Scottish secretary of the Royal Meteorological Society and senior lecturer in meteorological physics in the University of Edinburgh, and Mr. C. D. Ovey, a vice-president of the Royal Meteorological Society and lecturer in geography in the University of Cambridge. Visiting lecturers included Prof. G. Manley, who described the Helm Wind at Crossfell; Mr. W. V. Lewis, of the Geography Department, University of Cambridge, who gave a talk on the movement of glaciers and process of glacial erosion; Dr. S. R. Eyre, of the Geography Department, University of Leeds, who gave a lecture on microclimatology of the New South Wales coastal lowland; Dr. W. A. Fairbairn, of the Department of Forestry, University of Edinburgh, who spoke on climate and forestry; and Mr. E. G. W. Spence, who explained the construction and use of meteorological instruments. Towards the end of the course a visit was arranged to the Meteorological Office Station at Squires Gate, near Blackpool. An important part of the course consisted of observation work and the plotting of synoptic meteorological data. As in previous years, various education authorities and the Education Department of the R.A.F. made it possible for some of the students to attend the course, which is approved for grants in suitable cases. It is planned to hold a similar course in mid-August 1955; in view of the increasing number of applications received, a parallel course in 1955 for sixth-form students, to be held at the Juniper Hall Field Centre of the Council, is at present under consideration.

Archæology in Greece during 1952–53

The annual report for the session 1952–53 of the managing committee of the British School of Archæology at Athens, by J. M. Cook and J. Boardman, entitled "Archæology in Greece, 1952–1953", is reprinted from the *Journal of Hellenic Studies* (Vol. 74, pp. 64+4 plates. London: British School of Archæology at Athens), and summarizes the varied work of the year ending September 1953. The Greeks continue restoring ancient and medieval buildings up and down their country, and the Americans in the Agora at Athens are rebuilding the Stoa of Attalos—a colonnaded block of shops built in the second century B.C.—to serve as their museum and are also preparing to landscape other ruins. This sort of work offends purists; but ancient sites do not belong only to specialists. Excavators have been busy in Athens, Eleusis, Corinth, Mycenæ, Lerna, Argos, Olympia, Pylos, Crete, Chios, Thasos, Samothrace, and elsewhere; the most useful results are likely to

be for the Bronze Age. More entertaining discoveries are the dedication of the famous prostitute Rhodopis, the helmet of Miltiades (presumably the victor of Marathon), and what—it seems—the Athenians of the fifth century B.C., after archæological examination, wrongly identified as the graves of the Seven against Thebes.

Torquay Natural History Society

The impact of the Second World War of necessity curtailed the activities of the Torquay Natural History Society, and the centenary year of 1944 passed almost unmarked with the exception of a short historical article in the April issue of the *Museums Journal* in that year. Prior to this the Society had published papers from time to time in its *Transactions* on one aspect or another of its development and activities; but the main historical record remains that of Mr. Harford J. Lowe, published in four parts over the years 1909–13, on the growth and history of the Society. This is now more than forty years ago, and A. G. Madan, curator of the Museum, has prepared an account not only to bring the history up to date but also to report on the collections and present-day activities of the Society (*Trans. and Proc. Torquay Nat. Hist. Soc.*, **11**, No. 3). Much of the history is concerned with the excavations at Kents Cavern during which considerable evidence was unearthed which threw fresh light on the antiquity of man.

Oil Palm Research

The first annual report of the West African Institute for Oil Palm Research, just published (pp. 1–135. Benin City, Nigeria; and Crown Agents, 4 Millbank, London, S.W.1. 2*s*. 6*d*.), gives an account of the Institute's organization, research and field work for the period 1952–53. The first issue of the Institute's research journal, which contains detailed reports, has already appeared and has been noted in these columns (*Nature*, **173**, 19; 1954): and other publications are in preparation. While the scientific staff list still shows a considerable number of vacancies, the research policy, which is here defined in some detail, is being actively carried out in all its many aspects. The present report gives a comprehensive account of field studies, agronomy, chemistry, plant breeding, general botanical studies, pathology and statistics.

Canadian Biological Publications

With the support of the Research Council of Ontario, J. Murray Speirs, Ruth Kingsmill and George W. North, of the Ontario Fisheries Research Laboratory of the University of Toronto, have prepared a bibliography of Canadian Biological Publications for 1949. The bibliography, a most thorough and comprehensive survey, was assembled by searching biological journals in local libraries, and by following leads suggested by correspondents. Medical and commercial papers have been omitted unless the biological content predominated. The bibliography is arranged by subjects, and within the subject by author, publication, date and page. To anyone wishing to know of recent biological events in Canada this survey will be most valuable; its value would be considerably enhanced if its publication coincided more closely with that of the papers mentioned in it. The bibliography is published jointly by the Quebec Biological Bureau and the University of Toronto.

Annals of Library Science

The first number of a new quarterly periodical (**1**, No. 1; March 1954; published by the Times of India Press, Delhi; Rs. 10; 3 dollars; 20*s*.), edited by Dr. S. R. Ranganathan, contains two articles by Dr. Ranganathan on Depth Classification which include some criticism of the Decimal Classification and describe the emergence of the Colon Classification. The Universal Decimal Classification is also criticized in an article by Faqir Chand. These, like K. A. Isaac's article on dialectics of the Universal Decimal Classification, are continuations from the journal *Abgila*. The issue also contains a glossary of cataloguing firms by K. D. Puranik, a further article by Dr. Ranganathan on a library development plan for Delhi State, and one by G. Otterick and S. Mochlenbrock on training for library service in Sweden.

Callendar's "Radio-Balance" for determining the Thermal Energy of Radiation

In 1910 H. L. Callendar described a thermal-balance device which he called a "radio-balance" and which consisted of a calorimeter for the measurement of radiation in which the quantity of heat to be measured was balanced against the cooling from a Peltier couple. With this device he made measurements of the solar radiation and also of the energy emitted in unit time from a sealed source of radon which had been lent to him by Lord Rutherford. Since then the only other use of a radio-balance appears to be that of F. E. Hoare some twenty years later, who utilized the device to determine the Stefan–Boltzmann radiation constant. However, the radio-balance as an instrument for the measurement of energy dissipation has much to commend it, and the operation of the device has been extensively investigated recently by W. B. Mann (*J. Res. U.S. Nat. Bur. Standards*, **52**, 177; April 1954; Research Paper 2486) with the view of its use for the accurate determination of the energy emission from radioactive sources. Several radio-balances were constructed, and the final version consists of two copper cups 13/16 in. long and having internal and external diameters of 0·099 and 0·130 in., respectively. Each cup is mounted on a six-junction constantan-chromel thermopile, and the lower junctions of each thermopile are dipped into silicone oil contained in two small cavities in the lower copper block that constitutes the container of the radio-balance. A constantan-chromel Peltier couple is soldered to the base of each cup. Each cup may be used singly, and the cups may be used together in opposition. In the series of experiments described by W. B. Mann, measurements were confined to radium preparations contained in platinum–iridium needles of 0·5 mm. wall thickness. For an absorption equivalent to 0·126 cm. of lead, a heat emission of 128·9 cal. gm.$^{-1}$ hr.$^{-1}$ was found for radium in equilibrium with its products down to radium D. The estimated accuracy is $\pm$ 0·7 per cent. It is stated that it is proposed to apply the radio-balance described to the measurement of the average energy of beta-ray emitters, and a new radio-balance is being constructed for the comparison of the United States and Canadian national radium standards.

Dreyer's Catalogue of Nebulæ and Clusters of Stars

J. L. E. Dreyer's "New General Catalogue of Nebulæ and Clusters of Stars", giving descriptions

and positions of all the nebulæ known at the end of 1887, was published in 1888 (*Mem. Roy. Astro. Soc.*, **49**, Part 1; 1888), and this was later supplemented by his "Index Catalogue of Nebulæ found in the Years 1888 to 1894, with Notes and Corrections to the New General Catalogue" (*Mem.* **51**; 1895) and by the "Second General Catalogue" (*Mem.* **59**; 1908), which provided similar data up to the end of 1894. The Royal Astronomical Society decided to reproduce the three sections by photographic means and to include them in one volume under the title "Memoirs of the Royal Astronomical Society. New General Catalogue of Nebulæ and Clusters of Stars (1888). Index Catalogue (1895). Second Index Catalogue (1908)" (from the Society, Burlington House, London, W.1; 1953; £3 10*s.* post free, or £2 10*s.* to Fellows). This is very much more convenient for observers than the three separate volumes and, except for the alteration in the pagination of the two Index Catalogues to follow on from that of the "New General Catalogue", the catalogue has remained unaltered. In its present form this volume should prove very acceptable to observers of nebulæ and clusters.

Design and Accuracy of Volumetric Glassware

THE sixth in the series of "Notes on Applied Science" prepared by the National Physical Laboratory, Teddington, is entitled "Volumetric Glassware: Scientific Aspects of Design and Accuracy" (pp. 22. London: H.M.S.O., 1954; 1*s.* 6*d.* net). It presents the basic scientific information which must be taken into account in the preparation of standards for volumetric glassware and sets out the main features of standardization which are of general applicability in rationalization or verification. The information given is supplementary to that of any test pamphlets issued by the National Physical Laboratory and also to the British Standards issued by the British Standards Institution. The booklet does not discuss techniques of manufacture or the uses to which the glassware is put. It consists of three main sections dealing with the basis of graduation, the construction and verification of apparatus, and the dependence of volume delivered on delivery procedure. The first section contains a clear explanation of the three units of volume in use—the litre, imperial gallon and cubic foot—and the relationship between them; a discussion of the effect of temperature on the capacity of a glass vessel; and the definition of capacity involving either a volume of water or mercury and, in the case of a graduated glass vessel, the precise setting of the liquid meniscus to a horizontal line. Various details of procedure to be adhered to in the cleaning and in the determination of the capacity of a glass vessel are included in the second section. It is emphasized that all traces of detergents, which are now being increasingly used for cleaning glassware, must be carefully removed from volumetric glassware before calibration, otherwise the surface tension of the water used in the calibration, and consequently the shape of the meniscus, will be considerably affected. Also, all determinations of a glass vessel are based ultimately on the gravimetric method, so that when water is used for calibration and high accuracy is required, both the temperature and pressure of the air at the time of weighing should be recorded. The final section contains a detailed discussion of delivery times and drainage times of burettes and pipettes and is illustrated by several graphs and tables. The booklet concludes with a list of references and of British Standards relating to volumetric glassware.

Institution of Gas Engineers: Annual Report

THE ninety-first annual report and accounts of the Council of the Institution of Gas Engineers (Pub. No. 440; pp. 42; from the Institution, London; 1954), presented at the annual general meeting of the Institution in Bournemouth during May 31–June 2, includes a list of communications during the year, and the regulations for the award of the Charles Hunt Memorial Medals in gas engineering are appended. Five supplements to the fourteenth report of the Chairman's Technical Committee were issued during the year by the Gas Works Safety Rules Committee. These were concerned with a model specification for platforms, ladders and stairways to provide means of access to plant, a code of practice for the safe operation of tower purifiers, a note on the operation of electro-detarrers with carburetted water-gas plant, safety recommendations for electrical equipment in gas manufacture, purification and distribution, and additional references to the bibliography of literature relating to accident prevention. A booklet on "Unusual Incidents at Gasworks" was due to be published, and a supplement dealing with the internal protection of gas pipes has been issued by the Pipes Committee.

Museum of Comparative Zoology at Harvard College: Annual Report for 1952–53

THE annual report for 1952–53 of the Museum of Comparative Zoology at Harvard College (pp. 24; from the Museum, Cambridge, Mass., 1953) details the work of an institution which, though burdened with an antiquated name, executes an extremely important task. It is in effect mainly a research institution in which function is deemed of more importance than taxonomy, though studies in the latter are still undertaken. In addition, important additions have been made to the Museum collections, and several expeditions, including a survey of molluscs at the site of the Jim Woodruff Dam at Chattahoochee, Florida, have been undertaken. An impressive list of ninety-five papers published by the staff is some indication of the continued activity of this well-known Museum.

Reactor School at Harwell

As a step towards encouraging industry to play a greater part in the development of atomic power, the United Kingdom Atomic Energy Authority has opened a reactor school at Harwell. The new school will provide, for a fee of £250, a three-months course of training for staff from industrial concerns to learn the techniques by which heat from atomic piles can be converted into useful power. Priority will be given at first to staff of firms already acting as contractors to the Atomic Energy Authority. Some new graduate members of the Authority's own staff will also be trained in the school. Three courses will be held each year, the next in January 1955. The syllabus includes lectures and individual instruction in nuclear physics, reactor physics, metallurgy and reactor engineering, as well as experimental work. Lectures are given by experts drawn from various divisions at Harwell, and by the full-time school staff. Applications for places in the school should be made to the Manager, Reactor School, A.E.R.E., Harwell, Berkshire, and should give sufficient

information for the Management Board to assess whether the student has the required academic standard for entry to the School. It is expected that all students will be physics or engineering graduates or else have had considerable theoretical and practical experience in at least one branch of science or engineering. Mathematics up to subsidiary degree standard is necessary, particularly for the reactor physics lectures. The fee of £250 for the course does not include hotel accommodation; but the school is prepared to book hostel, hotel or guest-house places for students as available.

Fourteenth International Horticultural Congress, Scheveningen

The Fourteenth International Horticultural Congress will be held in The Netherlands at Scheveningen during August 29–September 6, 1955. Prior to the Congress, during August 25–27, excursions will be made to scientific institutions and to horticultural districts in The Netherlands. The Congress will consider vegetables and seeds; fruits; flowers and flower bulbs; trees, shrubs and perennials; and tropical and subtropical horticulture and plantation crops. Within each of these sections the following will be discussed: plant breeding and propagation; soils, fertilizers and water supply; plant diseases and pests; environment; and horticultural engineering, technology and technical marketing problems. Twenty minutes will be allowed for reading each paper, with ten minutes for discussion. The language may be English, French or German. The fee for membership of the Congress is 60 guilders (which includes a copy of the proceedings) or 25 guilders for an associate member. Application for membership should be sent to the Secretary of the Congress, Dr. G. de Bakker, Ministry of Agriculture, 30 Bezuidenhout, The Hague, from whom further information can be obtained.

Announcements

The Committee of Privy Council for Medical Research, after consultation with the Medical Research Council and with the president of the Royal Society, has appointed Prof. A. Bradford Hill, professor of medical statistics in the University of London, Prof. G. F. Marrian, professor of chemistry in relation to medicine in the University of Edinburgh, and Prof. G. W. Pickering, professor of medicine in the University of London, to be members of the Medical Research Council; it has also appointed the Honourable Richard Frederick Wood, M.P., to be a member.

The André Dreyfus Foundation has awarded the Dreyfus Prize for 1954 to Dr. Hans Kalmus, of the Galton Laboratory, University College, London. Dr. Kalmus intends to use his prize spending a semester (April–September 1955) in Brazil, working on problems of human genetics.

The Perkin Medal of the Society of Dyers and Colourists has been awarded to Dr. Arthur Zitscher for his work leading to the discovery of the new class of azoic dyes based on the arylamides of *o*-hydroxycarboxylic acids. The presentation will be made at a meeting of the Society to be held in the University of Manchester on October 15, when Dr. Zitscher will deliver a lecture on his work.

The Textile Institute Medal has been awarded to Sir Ernest Goodale, president of the Institute during 1939–40 and chairman of the Institute's London Section during 1950–52; the Medal was inaugurated in 1921 to mark distinguished services to the industry in general and to the Textile Institute in particular. The Warner Memorial Medal, awarded in recognition of outstanding work in textile science and technology, has been awarded to Mr. R. Meredith, of the College of Technology, Manchester.

The Scientific Instrument Manufacturers' Association is arranging an exhibition of electronic aids to production, design and research, under the title "Electronics at Work", to be held in the Chamber of Commerce Hall, Birmingham, during November 23–25. Admission is by ticket obtainable free on request from the Association at 20 Queen Anne Street, London, W.1, or from the Birmingham Chamber of Commerce, the Birmingham Exchange and Engineering Centre, or the Information Department, Birmingham.

The Spectroscopic Panel of the Hydrocarbon Branch of the Institute of Petroleum is arranging a conference on "Molecular Spectroscopy", to be held in the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2, during October 28–29. Further information can be obtained from G. N. Ross, Anglo-Iranian Oil Co., Ltd., Chertsey Road, Sunbury-on-Thames, Middlesex.

A second edition of the "Departmental Handbook" of the New Zealand Department of Scientific and Industrial Research (pp. 68. Wellington: Government Printer, 1954) has been necessitated by departmental reorganization, staff changes and the heavy demand for the first edition. The bulk of the Handbook is given to brief descriptions of the various Divisions, Laboratories, Sections, etc., of the Department, with lists of staff and also the incorporated research associations. These are supplemented by notes on the general organization and administration of the Department, its activities and responsibilities and development, with details of committees and an index. The Handbook is illustrated and is well produced.

The twenty-first annual Christmas symposium of the Division of Industrial and Engineering Chemistry of the American Chemical Society will be held during January 7–8, 1955, the subject being "Pulsatory and Vibrational Phenomena". The symposium will be broad in scope, with papers on the following subjects: shock phenomena; pulse extraction and other vibration devices in chemical engineering process operations; generation and effects, both physical and chemical, of ultrasonic vibrations; vibration problems in combustion; vibration effects on structures and structural materials; and high-frequency heating. Those intending to participate should write to the programme chairman, DeWitt O. Myatt, Atlantic Research Corporation, 901 N. Columbus Street, Alexandria, Virginia.

Erratum. Mr. R. Persson states that in his communication entitled "Measurements on the Neutron Multiplication in a System of Uranium Rods and Ordinary Water", published in *Nature* of August 7, p. 265, the results obtained from formula (4) should be corrected for the diffusion of slow neutrons from the reflector to the core. This correction is important, especially for the most compact lattices, and the experimental points are then in much better agreement with the theoretical curve.

RECRUITMENT IN THE ENGINEERING INDUSTRY IN BRITAIN

A JOINT discussion between Section G (Engineering) and Section L (Education) at the British Association meeting at Oxford on September 7 was opened by Dr. Willis Jackson, director of research and education, Metropolitan-Vickers Electrical Co., Ltd., who emphasized the great gap between the numbers and quality of recruits needed by the engineering industry and the boys actually coming from the schools. He stressed the importance of continued education, general as well as technical, and of systematic practical training. He believes, however, that there is a fundamental change in attitude on this question based on the recognition of its national importance and arising from the increasing number of men in high executive positions who themselves have had a sound engineering education. The engineering industry, Dr. Willis Jackson said, needs recruits at three levels—professional engineers, technicians, and craftsmen. These sometimes overlap; but each has an essential place in the industry, and he believes that it is the facilities for training technicians which are the least satisfactory, partly because the need for training them systematically has not been clearly appreciated. More deliberately organized courses of practical training and technical study are needed here; but Dr. Jackson stressed the need for more flexibility in training all types of recruits, and also the importance of corporate life during industrial training and the value of the activities of apprentice associations.

Dr. Jackson was particularly concerned with the recruitment of professional engineers. The number of corporate members admitted to the Institutions of Civil, Mechanical and Electrical Engineers has increased from 2,741 in 1951 to 3,310 in 1953, of whom 1,444 possessed a university degree, as compared with 1,215 in 1951. Nevertheless, while the facilities for engineering students at the universities have increased, they are not being used: three hundred first-year places in university engineering schools were unfilled this year and two hundred more will be available in the next three years. More disturbing still, in one university thirty per cent of those accepted failed to pass their first-year examination. Dr. Jackson wondered whether we are trying to draw into the university engineering schools boys who would be better served by entering industry as student apprentices. He also thought that there is a need for better means of informing boys and parents as to the nature and prospects of engineering as a career.

Mr. Donald Lindsay, headmaster of Malvern College, who followed, flatly challenged the assumption that it is the business of the grammar school to produce engineers or any other particularly qualified group. The percentage of able boys is limited to about ten per cent of the school population, and this proportion has to supply all the professions with their best men. In his opinion, the school should be neutral, and should not attempt to influence recruitment for any particular profession. Nevertheless, Mr. Lindsay believes that the engineering profession could do more to attract not the outstandingly able boy, who usually knows his own mind, but the less-able boy, who, like his parents, often has the vaguest ideas of what it means to become an engineer. He suggested that the engineering industries could follow the example of the Armed Services in preparing a single-page document explaining clearly methods of entry and age and educational requirements for their various branches. Mr. Lindsay is also concerned at the possible effect on the prospects of the less-able boys of the new certificate examinations at ordinary level, and still more at the consequences for such boys of the shortage of science teachers and especially the decline in quality of science teachers.

Mr. H. A. Warren, principal of East London Technical College, outlining the contribution of the technical colleges to recruitment and training for the engineering industries, pointed out that grammar schools provided 45 per cent of the technical college students who obtained their Higher National Certificate in 1953. He said that the quality of the work of the technical colleges reaches as high a standard as the grade of student entry permits. The standard of teaching is good, the scale of equipment excellent and also the co-operation from industry, and so far as the student is characterized by a narrowness of outlook, it should be corrected by the philosophy and outlook of this age. Technology, he urged, should be restored to the service of the liberal ends of human life and character; and, referring to the proposals for a new national award in technology, Mr. Warren said that not only has any new award to prove its worth, but also it is essential for it to encourage breadth of outlook and height of aspiration, thus bearing witness to those social, cultural and philosophical qualities which were the original characteristics of a university degree.

ATTITUDES TO WORK

IN an address to the Industrial Section of the British Psychological Society*, Prof. L. S. Hearnshaw stated that as soon as psychologists have become convinced that values have a place in the world of fact and not only in the heads of philosophers, and that they are capable of being investigated by empirical means, the main resistances to their study will have been overcome, and one of the chief regulators of human behaviour brought within the framework of psychological study.

The growing number of attitude surveys that have been carried out among industrial workers since the War is a recognition that this area of psychology is industrially important. For the study of attitudes merges necessarily into the study of values. The difficulties confronting the psychologist in these studies are formidable and even discouraging.

The most suggestive observations on attitudes to work have come not from industrial psychologists—with the exception possibly of Mace, who is a man of many parts—but from an economist, like Zweig, a historian, like Carr, a philosopher, like Salmon, or from the mainly amateur members of productivity teams.

On the whole, the studies carried out by industrial psychologists themselves in the field of industrial attitudes have been restricted in their frames of

* *Occupational Psychology*, **28**, No. 3 (July 1954).

reference. They have been concerned, broadly speaking, with three main topics. First, there have been studies of attitudes to specific features of the industrial environment, to wages and wage systems, security, status, supervision, working conditions, unions, industrial relations policies, types of job, and so on. Secondly, there have been comparative studies of the sort carried out by Marriott in Britain and by various groups in the United States, in which different factories have been compared with regard to attitudes, and an attempt made to link differences in attitude to features of the industrial situation. Thirdly, there have been studies of changes in attitudes resulting from changes in the industrial situation, both planned and unplanned.

Attitude studies along these lines have a twofold value. They provide a knowledge of the features within the industrial situation that influence and modify attitudes, and they provide local knowledge of attitudes to various situations which is of diagnostic value in troubled industrial conditions and a pointer to management.

In modern technical civilizations work has increasingly become a demarcated area of life. There is for more and more people a recognizable meaning in phrases such as 'on the job', 'working hours', 'retirement', in a sense quite unlike anything that obtains, or has obtained, in a simpler peasant or craft economy. A characteristic feature of work is that it is an activity performed under obligation. The individual undertakes to carry out certain duties (this word in itself is significant) in a certain manner, and usually, though not always, to be in certain places at certain times.

There are other attributes of work such as the fact that it usually implies activity continued over a period of time, perhaps a lifetime, and pursued with some regularity—odd jobs are the vanishing point of work—and also the fact that it is commonly integrated into the economic system.

If work is a demarcated area of life, this area can be evaluated in importance in relation to other areas. An individual's attitude to work will partly depend upon this evaluation. Secondly, if work implies obligations, an individual's attitude to work depends partly on his grasp and his acceptance of these obligations, and the qualitative standards of performance which serve as his norms or models.

Certain broad conclusions seem clearly to emerge from cross-cultural studies of this kind and to confirm qualitative studies which have been made. First, attitudes to work are cultural acquisitions bound up with many features of social organization, economics and ideology, and linked to personality structure; secondly, the roots of these attitudes go deep into the historical past; thirdly, though extremely persistent, such attitudes are not unchangeable.

There is a good deal of clinical and psychoanalytical evidence suggesting that personality structure and attitude to work are closely related, that work is one of several ways of securing reassurance against neurotic anxiety—a way agreeable to some, to others profoundly disagreeable. Attitudes to work cannot be understood except against the whole background of a culture and the predominant personality structure that goes with it.

Attitudes, however, though often persistent and stretching back into history, are not unchanging or unchangeable. Strong attitudes may slowly and imperceptibly erode and decay. New attitudes may emerge in response to the challenges of man or Nature. Although there are difficulties in interpreting this evidence, it all points in the same direction and to suggest that attitudes to work have eroded more in Great Britain than elsewhere. Not much can be done about this until more is known.

Into the problem of attitude to work three lines of research suggest themselves: the comparative, the genetic, and the psychometric.

Less is known about the character structure of the good workman, technician or professional man than the character structure of the young delinquent; the underworld has had more than its share of psychological attention. Attitudes to work are acquired in the process of growing up. What in fact are the formative influences upon which such attitudes primarily depend? What part do family influences play? To what extent in our culture are attitudes to work acquired at school? What is the effect of different types of education, or vocational placement, of the way a young person is introduced to work, of methods of industrial training, of blind-alley jobs? Again, what permanent influence do breaks in continuity of work have—military service, for example, or periods of unemployment? These and numerous other questions can be asked, but scarcely answered.

Work, not in the sense of physical effort, but work as a mastery of technique, as control, attention and service is the lynch-pin of modern society; and work in this sense depends even more than does physical labour on the attitude of those who perform it. Attitude to work is fundamental to the very continuance, still more to the progress, of society. There is no more important question for the industrial psychologist to turn his attention to than the way attitudes to work arise, grow and are transmitted.

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION, AUSTRALIA

ANNUAL REPORT FOR 1952–53

FOLLOWING the practice adopted in the previous report, in the fifth annual report of the Commonwealth Scientific and Industrial Research Organization, Australia, covering the year ended June 30, 1953*†, material is arranged according to its subject and not the Division or Section concerned. Expenditure for the year totalled £4,526,270, including £1,044,392 from sources other than the Commonwealth Treasury, notably £327,283 from the Wool Industry Fund and £455,273 from the Wool Research Trust Fund. Continued progress is reported in the erection of new buildings, and the new laboratory for the Division of Tribophysics was practically complete.

Detailed surveys carried out by the Division of Soils covered about seventy thousand acres and broad-scale surveys about fifty thousand square miles, the field-work for about half the Melbourne sheet of a revised soil map of Australia being completed during the year. In soil chemistry, work on

* Commonwealth of Australia. Commonwealth Scientific and Industrial Research Organization. Fifth Annual Report for the Year ending 30th June, 1953 (1952–1953). Pp. vi+290. (East Melbourne: Commonwealth Scientific and Industrial Research Organization, 1953.) n.p.

† Commonwealth of Australia. Fifth Annual Report of the Commonwealth Scientific and Industrial Research Organization for the Year ending 30th June, 1953. Pp. 191. (Canberra: Government Printer, 1953.) 11s.

manganese-deficient soils continued and that on the ion exchange–*p*H relations in cation-dominant soils is almost complete. Work is in progress on a modification of the rapid Passon method for determining free carbonates in soils, and factors affecting the growth of strains of *Rhizobium trifolii* in the rhizosphere of subterranean clover have been investigated. Attempts to fractionate humic acid into its colloidal constituents failed.

In the Division of Plant Industry increased emphasis was given to fundamental studies, and work on plant chemistry, biochemistry, physiology, microbiology, genetics and cytology is to be extended. Although no officers were collecting overseas, plant exploration dominated the work of the plant introduction unit. Some of the varieties of tall fescue continued to be outstanding in pasture introduction trials at Armidale, New South Wales, and strains of chick pea from Spain and Eritrea appear to be useful, drought-resistant, quick-growing forage plants. Nearly seven hundred new introductions were established in the quarantine nursery at Strathpine, Queensland, chiefly large collections of pasture and crop plants from Africa. Potato varieties infected with virus X have been successfully reconstituted by treatment with the dye malachite green, and comparative *in vitro* tests have shown that streptomycin and aureomycin are more effective than bacitracin, chloromycetin, terramycin and penicillin in inhibiting growth of *Corynebacterium michiganense*, *Xanthomonas vesicatorium*, *X. phaseoli*, *X. campestris*, *Pseudomonas medicaginis* and *P. syringae*. A start has been made on the determination, from each important group of soil microflora, of the numbers which can normally be expected to be present in known fertile soils at different seasons. It has been shown that the reduction of ferric compounds by bacteria results from reducing conditions caused by dehydrogenase systems, and this type of reduction may be important in supplying plant nutrients from iron and manganese oxides.

Preliminary trials on Golden Delicious, Delicious, Granny Smith and Sturmer apples indicate that storage in low concentrations of oxygen in absence of carbon dioxide gives very promising results, scald and breakdown being reduced and texture greatly improved. Investigations on the effect of nitrogen and plant spacing on leaf quality and also on the effect of temperature on the resistance of tobacco plants carrying the necrotic type of resistance to tobacco mosaic were continued. The prevalence of trashy leaf causes considerable losses to the Australian tobacco industry, and the qualitative and quantitative changes in composition of glasshouse plants submitted to treatments conducive to trashiness are being studied. Trials with potassium, copper, zinc, molybdenum, manganese, iron, magnesium and boron on soils in the Southern Tablelands of New South Wales were maintained, and a programme of work has been initiated which should provide detailed information for the solution of subsidiary nutritional problems in the Ninety-Mile Plain area, particularly relating to zinc and copper requirements and the function of these elements in the general physiology of plants. An attempt is being made to determine whether varieties of oats differ in the efficiency with which they utilize copper within the plant. Studies of the distribution of treeless grasslands in south-eastern Australia in relation to soil, climate and fire are in progress; and a detailed study has been commenced of the rate and nature of the improvement of fertility by subterranean clover in New South Wales. Ecological surveys of pastures continued in the New England region of New South Wales, in south-western Queensland and at Deniliquin, where studies with a range of irrigated pastures on several soil types also continued. Studies at Perth of the factors affecting zinc responses in subterranean clover indicate that high levels of soil moisture increase the zinc requirements and that a high level of available nitrogen hinders the utilization of zinc in the soil. Studies on the black soils of the Darling Downs now completed indicate that nitrogen and sulphur are the primary limiting plant nutrients. The large-scale grazing experiments at Lawes with the grass *Paspalum scrobiculatum* and lucerne indicate that the two plants are complementary in terms of production and in providing an overall balanced diet for stock. The range of concentrations of zinc and copper in subterranean clover and lucerne on soils of the Coonalpyn Downs has been investigated as an aid to the diagnosis of incipient deficiency of zinc and copper, and preliminary studies indicate that 3-(*p*-chlorophenyl)-1 : 1-dimethylurea is a powerful herbicide, acting chiefly through the root system.

The Irrigation Research Station at Merbein, Victoria, where a programme of research on breeding tomatoes resistant to nematode and other pests and diseases has proceeded for some years, is broadening its interest in nematology, while much of the work of the Irrigation Research Station at Griffith, New South Wales, has been concerned with the principles and methods of applying water, and the removal of surplus water by drainage. Only slow progress is reported with the establishment of the Sheep Biology Laboratory at Prospect Hill, Parramatta, Sydney, where basic physiological and biological studies of the sheep are to be concentrated. At the National Cattle Breeding Station, Belmont, Rockhampton, methods so far adopted to control infestation by tick (*Boophilus microplus*) appear to be of limited value. The investigation of breeding systems at the Poultry Research Centre, Warribee, Victoria, indicates that the most effective way of improving characters of a quantitative nature with low heritability in a pure-bred population is by selection of genetically superior parents, which are discovered by progeny or sib-testing, or both, and by mating to avoid close in-breeding. Experiments on nutrition and wool production have been extended to provide further knowledge of the metabolism and utilization of methionine, which is convertible *in vivo* to cystine, the main amino-acid in wool keratin. Studies of the physiology of the wool follicles have also been initiated to extend existing knowledge of the process of keratinization. The effects of insulin on sheep and lambs have been studied further, and studies of the relations between vitamin B_{12} and cobalt ingestion in the sheep have shown that the syndrome of cobalt deficiency is due to vitamin B_{12} deficiency.

The Animal Genetics Section has undertaken a survey which is designed to indicate the total variation between sheep throughout Australia in quantity and quality of wool production and the fraction of variation which can be apportioned to genetic and other causes. Further observations have been made on the relation of particle size of phenothiazine to its anthelmintic efficiency, the mode of action of phenothiazine and related compounds, the techniques of drenching sheep and resistance to nematode parasites. With proper dipping technique, at the concentration generally recommended, benzene hexa-

chloride promises to eradicate *Linognaltus ovillus* on sheep. Further work on pleuro-pneumonia of cattle is reported, on mastitis in dairy cattle, on brucellosis in cattle and on infectious bovine ophthalmia. Further work has shown that loss of efficiency of benzene hexachloride dipping fluids is related to a selective depletion of the toxic gamma isomer.

In the Division of Entomology the Biological Control Section has intensified its work on the green vegetable bug and is endeavouring to establish parasites of the oriental fruit fly which will give some control of the Queensland fruit fly. Promising methods of controlling cattle tick and lucerne flea have been evolved, and a new virus attacking a pasture caterpillar has been discovered. Periodical surveys of the main infestation areas of St. John's wort (*Hypericum pertoratum*) continued, and long-term field studies on insect populations were commenced. Field experiments with DDT indicate that very satisfactory control of the earth mite can be achieved by proper application, and a large-scale eradication campaign against the Argentine ant is to be carried out in an area of 1·5 square miles near Sydney. Some progress is reported towards the development of an insect-proof packing material.

The Wild Life Survey Section shifted its interest in myxomatosis from extensive survey to more intensive studies of special aspects of this problem. Joint investigations with the Tasmanian Fauna Board on the economic biology of the mutton bird (*Puffinus tenuirostris*) were continued in the Furneaux Group and extended to Trefoil Island. An investigation of the role of the straw-necked ibis (*Threskiornis spinicollis*) and the white ibis (*T. molucca*) in the natural control of locusts and to define measures for the preservation of their breeding haunts is under consideration, and the Section is to undertake the establishment of a national bird-ringing scheme. The Land Research and Regional Survey Section has since 1946 completed surveys of 223,000 square miles of under-developed regions in northern Australia, and a second unit is about to commence a survey of the Buna region of Papua. These broad-scale ecological studies determine both the distribution of the native vegetation and the possibilities of growth and establishment of fresh crop and pasture species. They include the assessment of land-use potential, research into problems of agricultural and pastoral development of the zones, climatological studies and a general topographical survey.

In fisheries research more time is being devoted to observations in south-eastern waters on water and plankton conditions, and studies are being made of gummy shark (*Emissola antarctica*) and the fishes of the continental shelf. Progress is reported in the recording of underwater shoals of pelagic fish by echo-sounding. Much useful information on the transport of small fish fry, particularly *Mugil cephalus*, from the small creeks and estuaries around Moreton Bay, was obtained before the lagoon was rendered useless for experimental purposes by the destruction of the sand barrier. Another fish farm for the culture of mullet fry in Moreton Bay is under construction, and the fish culture experiment at Maianbar is proceeding. A detailed investigation of the 'white crayfish' occurrence in coastal areas was made in December 1952, and preliminary biological surveys of prawns were made in north-west waters of Western Australia. Sufficient data have been collected to interpret and predict changes in the scallop fishery. A spectrophotometric method was devised for the determination of phytoplankton densities.

Special reference is made in the report to the co-operation of the Biochemistry Department of the University of Sydney with the physical chemistry group of the Division of Food Preservation and Transport. During the year, the Division commenced a survey of the nature and extent of wastage in cooked prawns for the Chief Secretary's Department of New South Wales and a survey of the Victorian Fishermen's Co-operative cold stores and their operation for the Victorian Department of Fisheries and Game. The study of the chemical composition of apricots and peaches continued. Experiments to increase the biological efficiency of the freeze-drying process for cultures have commenced, and the sudden rise in respiration about the time of ripening has been investigated in apples and pears. Use of the maturometer has made long-term prediction of pea-crop maturity a practical possibility, but the instrument requires modification for use with green beans. Trials of the removal of 'bloom' from the surface of grapes by immersion in warm ethylene dichloride have been extended to the currant and sultana, and the hot sulphite dip for sultanas has been applied by growers at Woorinen with very satisfactory results. Butter-milk, as well as skim-milk, has now been utilized satisfactorily as an addition to bread. Work on the physiological mechanism by which *Lepidium* spp. causes a high content of indole and skatol in milk and cream has stopped. A stock of efficient single-strain cheese-starter cultures has been established.

The Division of Forest Products has investigated the characteristics of tension in wood by microchemical and X-ray diffraction methods and has constructed a rheometer for measuring stress–strain–time relations on paper strips which will be used to study the relation of physical properties to the structure of paper and also manufacturing problems. The essential changes induced in cellulose fibres by beating, and the relation between the moisture intersection point obtained from strength studies and that determined from shrinkage studies are being investigated, and the increase in apparent density of wood substance with external swelling due to the displacement liquid has been confirmed. A study of the effect in laminated beams of using external laminæ of relatively strong species over a core of lighter and weaker material was completed, the high-pressure pilot plant was in almost continuous operation for the experimental treatment of rail-sleepers for co-operative tests, and a series of tests on the resistance to leaching of nineteen water-borne preservatives has given a valuable picture of the relative permanence of different preservatives. An investigation on the manufacture of plywood from veneers immunized against termite attack was commenced, and a spectrophotometric method developed for determining amino groups.

In the Division of Building Research greater emphasis was given to the work on lightweight aggregates and the use of plaster of paris as a structural material, the long-term study of the mechanism of failure of concrete under load and investigations on foamed concrete continued, and the survey of clay resources and the heavy clay industry in New South Wales and Victoria was completed. In the Wool Textile Research Laboratory at Sydney the study of the physical properties of single fibres is being extended to fibre assemblies and

the physical properties underlying textile processes. Other work on wool textiles has included X-ray studies of the transformation of α-keratin to β-keratin, the application of resins to wool, the construction of a Hepp-type of osmometer to determine the mean molecular weight of wool dispersions prepared by extraction with urea-bisulphite solutions and the study of protein structure, while good yields of alcohols have been obtained in small-scale hydrogenation of wool-wax acids at 300° C./4,000 lb. per sq. in. in the presence of copper chromite catalysts. Work on the pilot-plant scale on the aerated retting technique for treating flax was completed, and possibilities of improving flax-scutching machinery were being explored.

The Division of Industrial Chemistry continued its fundamental work on the carbides and iodides of thorium in relation to the thermal deposition of the metal, on the fluorides of cerium and their use as fluorinating agents and on the preparation and properties of titanium nitride, and is to conduct research on a large pilot-plant scale on a new method of treating copper concentrates, sponsored by Mount Lyell and Mount Morgan mining companies. The study of portland cement and pozzolanic cements and the survey of Australian resources of ceramic clays continued. A systematic study of the theoretical and experimental aspects of the chemical effects of high pressure was initiated and the work on the purification of antibiotics by fractional adsorption processes was concluded. A study of the physical and chemical properties of spread monomolecular layers has shown that the monolayer techniques can be used advantageously for determining the general architecture of molecules of between twelve and forty carbon atoms and the position of chemically reactive groups within the molecule. Techniques have been established for obtaining reproducible evaporated films and for measuring their thickness by multiple-beam interferometry, and a novel approach to the spectrochemical estimation of elements, invoking atomic absorption rather than emission, is being developed. In organic chemistry, apart from the chemistry and utilization of wool wax and sugar-cane wax, the research programme is concerned chiefly with the examination of Australian plants for alkaloids of pharmaceutical value and substances toxic to livestock, the kinetics of the phenol–formaldehyde reaction, the general chemistry of long-chain aliphatic compounds and the examination of seed oils from Australian plants.

Some work was done on the application of gravity and magnetic methods of concentration for the recovery of wolfram and scheelite from a fine-grained ore from New South Wales, and an intensive investigation commenced on the flotation of cassiterite. Fuel research included a pilot-scale investigation of the carbonizing properties of Australian coals and of the gasification of Victorian brown coal. Detailed investigations of titanium–tin and titanium–silver alloys were completed, and an X-ray diffraction study of the lower oxides of titanium has assisted the interpretation of the structure of oxide scale layers formed in the oxidation of titanium. The Division of Tribophysics has extended its work to include fundamental studies in metal physics and work on reaction kinetics, and reports major advances in the understanding of distortions produced in metals by plastic deformation. A study of the oxidation of propylene suggests that higher aldehydes are formed as a result of the decomposition of peroxides produced by a similar mechanism to that in the simpler liquid-phase reactions. Work on the thermal conductivities of organic vapours continued.

The Division of Metrology was again mainly occupied with statutory and industrial requirements relating to national standards, but also produced and measured three end-standards and platen for an international intercomparison arranged by the International Bureau of Weights and Measures. In low-temperature physics the Division of Physics began an examination of the thermal conductivity of various metals, and a study of the condensation of vapour on a solid surface has shown that, at very low supersaturations, condensation is due to imperfections of the surface. Research on the theory of optical instruments continued, and considerable progress was made in the construction of equipment for solar research. In electrotechnology work continued on the relation between the chemical and physical structure of organic compounds and their dielectric properties. The Division of Radiophysics continued its fundamental work in rain physics and radio-astronomy and also investigations on electronic computing and radio aids to navigation. Much information has been obtained about ionospheric winds, and the Organization has now embarked on intensive studies of the physics of the atmosphere. The work of the Meteorological Physics Section is directed to a more fundamental understanding of the weather and the physical processes which control it. With its new radio-spectroscope, the Division of Radiophysics has discovered a new phenomenon—the production of 'harmonics' of bursts of radio-emission from the sun.

Much of the work of the Nuclear Physics Section was concerned with angular correlations between particles participating in nuclear reactions, with nuclear energy-level determinations, and with scattering investigations. The cosmic-ray spectrometer determination of the variation of the specific ionization of cosmic-ray mesons as a function of their momentum was completed at Melbourne, and directional measurements of cosmic-ray intensity at Hobart continued. In mathematics the analysis of rainfall records and statistical studies of sheep-breeding continued, and effort was concentrated on the final development and use of the electronic computor, while work is almost complete on the development and application of beam-deflexion valves for digital computing.

A CHAINOMATIC PYCNOMETER FOR THE DETERMINATION OF CHLORINE IN SEA WATER

By D. J. ROCHFORD

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IN the early part of the present century, Nansen[1] used hydrometers for the determination of the salinity of sea water, and this method has been used to a limited extent since that date. However, Nansen was quick to realize the limitations of a hydrometer with an emergent stem, and tried to improve the pycnometric method by using totally immersed floats and holding them in equipoise with added weights. Pettersson[2] greatly improved the original idea of Nansen by using a gold chain as the source of weight, and other mechanical improvements. Petters-

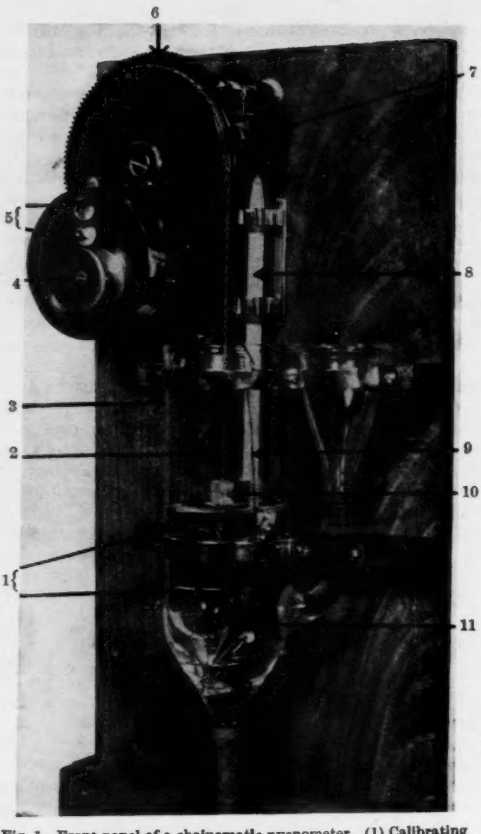

Fig. 1. Front panel of a chainomatic pycnometer. (1) Calibrating lines; (2) gold chain; (3) float chamber; (4) chain-adjusting knob; (5) chain-setting dials; (6) chain drum; (7) tension clutch; (8) thermometer; (9) float lifter; (10) chain guide; (11) float

son described two pycnometers, one with the gold chain as a tail on the float and operated in a tall cylinder in some 500 ml. of sea water, and the other utilizing the chainomatic principle in which gold chain was added link by link from a drum to the top of the float. This second pycnometer was essentially a laboratory instrument, and according to Pettersson, if the temperature was controlled it was capable of high accuracy of density determination.

The Division of Fisheries of the Commonwealth Scientific and Industrial Research Organization has been making extensive investigations of the coastal and estuarine environments of Australia, and a rapid accurate method of determination of chlorine capable of use by field-staff under rather primitive conditions seemed highly desirable. The pycnometric method of salinity estimation was finally chosen because it is a direct physical method, which without the range of equipment needed for a chemical determination or the skill required to construct and maintain electronic equipment is in our experience capable of high accuracy in the hands of semi-skilled operators. Moreover, it is capable of linear operation over the whole range of salinity from sea water down to fresh water.

The chainomatic pycnometer of Pettersson was adapted to our needs and the model now in use possesses the following improvements on his design. (*a*) It is portable, folding as a unit into a carrying case, 15 in. × 7½ in. × 3½ in. (*b*) The glass parts are extremely rugged. (*c*) Certain mechanical features, particularly the tension clutch in Fig. 1 (7) and the 'Perspex' chain guide (10), ensure perfect reproducibility of chain setting and lead to high accuracy of initial determination by users of the instrument. (*d*) The calibration is in $Cl^{o}/_{oo}$ units, and calibration graphs enable rapid conversion of instrument data into $Cl^{o}/_{oo}$.

The chainomatic pycnometer used by the Division was exhibited at the 8th Pacific Science Congress at Manila in November 1953 and attracted much interest from the oceanographers present. A sample unit has been sent to Canada for use in coastal oceanographical studies. It is hoped that this instrument will be in commercial production by an American firm at an early date. A technical description of the instrument and its use is being submitted for publication. [July 23.

[1] Nansen, F., *Norske Vidensk Selskabets Skrifter*, **1**, No. 3 (1905).
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INTERDEPENDENCE OF TEMPORAL AND AUDITORY JUDGMENTS

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WE have previously presented evidence that judgments of the spatial and temporal components of space-time events are interrelated[1,2]. We have used the term '*kappa*-effect' to denote the influence of the spatial component on judgments of duration to distinguish it from the *tau*-effect[2], which denotes the influence of the temporal component on spatial judgments. In our earlier report we referred briefly to the effects of order of presentation of the display and of visual angle. These effects and the relation between the *kappa* phenomenon and the perception of movement have been more fully described in a paper awaiting publication elsewhere.

In the experiments now to be described we consider the question, raised in the first report, whether the spatial element as such is an essential feature of this type of temporal phenomenon, and whether a delimitation of the time intervals by non-spatial stimuli such as auditory pitch might not produce similar effects.

One effect may be studied by presenting a cycle of three different tones. The flashes of light (as in the previous experiment) are now replaced by brief tones to delimit the temporal intervals, and distance is replaced by tonal interval. A second effect may be studied by means of a temporal interval which is not delimited by two tones but is itself indicated by a continuous single tone. In the first case we are concerned with the influence of tonal intervals on temporal judgment, and in the second case with the influence of continuous tones as such on the temporal judgment.

Effects with Tonal Intervals

(*i*) *Auditory tau.* The subject heard through headphones a repeated succession of three different tones of brief and equal duration and was required to adjust the pitch of the second tone until it seemed

Table 1. AUDITORY *tau* EFFECT FOR TONAL INTERVALS
Mean frequency (and standard deviations) of middle tone from adjustments by subjects ($n = 8$). $T(t_1 + t_2) = 1{\cdot}47$*

$\frac{t_2}{t_1}$	Frequency (c./s.) of first tone (upper figure) and third tone (lower figure)			
	1,000 3,000	2,000 4,000	4,000 2,000	3,000 1,000
0·5	1,676 (230)	2,628 (260)	2,837 (261)	1,921 (292)
1·0	1,874 (211)	2,693 (483)	2,808 (246)	1,838 (274)
2·0	2,068 (276)	2,786 (295)	2,674 (297)	1,725 (245)

* The duration of the complete cycle was 1·5 sec., of which 0·03 sec. was taken up by the onset and fading of the tones necessary to remove clicks.

intermediate in pitch between the first and the third tones. Each cycle of three tones was repeated after an interval of 5/3 of the total cycle. The two successive time intervals (t_1 and t_2) delimited by the three tones could be varied by the experimenter by adjusting the position of the middle tone in the cycle. The three ratios of t_2/t_1 employed were 0·5, 1·0 and 2·0, the total interval remaining constant at 1·5 sec. The frequencies of the first and third tones were set by the experimenter to provide tonal intervals of different magnitude and ascending and descending order. The frequencies used are shown in the column headings of Table 1.

The tones were generated by three audio-oscillators which fed into a mixer embodying a mechanism whereby each tone could build up and fade out in a short period of time so as to remove click disturbances. The sequence of the brief tones was controlled by a continuously rotating switch making contact with three positions, the centre position being variable.

The values in Table 1 are the means for eight subjects, each subject giving two judgments under each of the twelve conditions. It appears from these figures that when the observer is adjusting the second tone so that it seems to him intermediate in pitch between the first and third tones, he makes the tones which are presented closer together in time farther apart in frequency, regardless of the ascending or descending order of the tones. He does this because as, for example, t_2/t_1 is reduced to 0·5 after his adjustments when $t_2/t_1 = 1$, the tones delimiting the shorter time interval (t_2) seem too close together in pitch. In order to make the middle tone appear intermediate in pitch between the first and third, he reduces its frequency, thus increasing the frequency difference between it and the third tone. For example, when $t_2/t_1 = 0{\cdot}5$ and the first and third tones are 1,000 and 3,000 respectively, the mean frequency for the second tone is 1,676 c./s. as compared with 1,874 c./s. when $t_2/t_1 = 1$.

When $t_2/t_1 = 0{\cdot}5$, an interval of 1 sec. is followed by an interval of 0·5 sec. When $t_2/t_1 = 2{\cdot}0$, the reverse is the case. If we combine the figures in Table 2 so as to eliminate the effects of order of presentation of time intervals and ascending and descending order of frequency, there is a mean deviation of 8 per cent when the first and third tones are 1,000 and 3,000 c./s. and about 3 per cent when they are 2,000 and 4,000. Both these deviations are significantly larger than zero at the 0·05 level. Thus the *tau* effect is present under both conditions and is larger when the difference between the outer tones is greater. With the difference between the two tones smaller (2,500, 2,973 c./s.), no significant effect was observed under the above experimental conditions.

Table 2. PERCENTAGE DEVIATION OF JUDGMENTS FOR UNEQUAL TEMPORAL INTERVALS WHEN COMPARED WITH EQUAL TEMPORAL INTERVALS

$\frac{t_2}{t_1}$	Frequency (c./s.) of first tone (upper figure) and third tone (lower figure)			
	1,000 3,000	2,000 4,000	4,000 2,000	3,000 1,000
0·5	− 10·6	− 2·4	1·0	4·5
2·0	10·4	3·5	− 4·8	− 6·1

(*ii*) *Auditory kappa.* The procedure was the same as for the auditory *tau* except that the observer was required to adjust the timing of the middle tone so that t_1 seemed to equal t_2. The frequency of the middle tone was set by the experimenter so as to make three different ratios of tonal intervals.

The results obtained possibly suggest a very slight tendency for comparative judgments of two successive time intervals delimited by successive tonal intervals to be influenced by the relative magnitudes of the two intervals. The results, however, are not statistically significant.

Effect with Continuous Tones

The apparatus was modified so that each temporal interval was indicated by a continuous tone, the second immediately following the first. The tones were set by the experimenter and the subject was required to make an adjustment so that the two tones seemed of equal duration.

Table 3. AUDITORY *kappa* EFFECT FOR CONTINUOUS TONES
Mean for eight subjects when $T(t_1 + t_2) = 1{\cdot}47$ sec.*

(i)		(ii)	(iii)	(iv)	(v)	(vi)
First tone f_1 (c./s.)	Second tone f_2	$\frac{t_2}{t_1}$	t_1 (sec.)	σt_1 (sec.)	t_1' (sec.)	$\frac{t_1' - t_2'}{t_1'} \times 100$ (percentage)
3,000	1,000	1·06	0·715	0·062	0·682	− 15·5
4,000	2,000	0·91	0·771	0·059	0·735	0·0
2,973	2,500	0·95	0·755	0·042	0·720	− 4·2
2,500	2,973	0·83	0·803	0·081	0·765	7·8
2,000	4,000	0·85	0·794	0·072	0·756	5·6
1,000	3,000	0·85	0·793	0·070	0·756	5·6

* See footnote to Table 1.

In col. i of Table 3, we show the pairs of successive tones presented by the experimenter, and col. vi shows the corresponding percentage effect. In col. v a correction has been applied to eliminate time error by multiplying the values in col. iii by a constant derived from the mean of all the readings.

It appears from col. vi that there is a tendency for the time allotted to the higher tone to be less than that allotted to the lower tone. As in the case of auditory *tau* for tonal intervals, the effect appears most marked with the greatest difference in frequency between the two tones.

We have shown that auditory and temporal judgments are interdependent, the *tau* effect appearing most markedly with three brief tones and the *kappa* effect most markedly with two continuous tones. There is a reduced *kappa* effect with three tones, as compared with the corresponding *tau* effect. This is possibly due to the fact that, whereas in the *tau* experiment the subject has to attend to the pitch of the three tones in order to make his adjustment, in the *kappa* experiment he can make his adjustment by disregarding the pitch of the tones as such and attending to them as delimiting temporal intervals.

The subjects' verbal reports support this explanation. In the case of *kappa* with two continuous tones, the subject is compelled to attend to the tones throughout the entire cycle in order to discriminate between them and make his adjustment.

Having demonstrated the interrelation between (i) temporal and spatial and (ii) temporal and auditory judgments, we can now say that the spatial component as such is not an essential feature in these phenomena of interdependence. It may be asked whether the temporal element as such is essential, and whether spatial and auditory judgments are interconnected in the same manner when the temporal component is absent. Preliminary experiments have thus far failed to show an effect comparable to *tau* or *kappa* when the temporal element is absent, though other forms of interrelation between spatial and auditory judgments have been demonstrated in our own laboratory and elsewhere.

These experiments indicate the pervasive character of the temporal component in perception and the need for further study of its effects. [June 22.

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[2] Price-Williams, D. R., *Nature*, **173**, 363 (1954).
[3] Helson, H., and King, S. M., *J. Exp. Psychol.*, **14**, 202 (1931).

SHIELDING EFFICIENCY OF CATIONS

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IT is quite generally accepted that the 8-electron shell is able to shield the nuclear charge of an atom more efficiently than the 18-electron shell. The main object of this communication is to suggest a quantity which may be used for comparing the shielding efficiency (S_{eff}) of all cations; but before doing so, the sense in which shielding efficiency will be used here will be illustrated by two examples.

Consider first the 8- and 18-electron cations, Na^+ and Cu^+. They both carry unit charge and have the same radius[1,2] (0·95 A.); yet, whereas only 5·1 V. is required to remove an electron from an atom of sodium in sodium vapour, 7·7 V. is required to ionize copper to Cu^+. Evidently the 4*s* electron in copper is more tightly held than the 3*s* electron in sodium, and the principal, though not the only, cause may be considered to be due to comparatively poor shielding by the 18-electron shell.

In the above example, singly charged cations were considered; but for more highly charged cations, the equivalent ionization potential will be used—the second for doubly charged cations, the third for trebly charged cations, and so on: thus, comparisons are always made of the energy required to remove one electron—the last one—to give the particular ionic state in question.

As a second example, we may take the pair Zr^{4+} and Hf^{4+}, each with a charge of four and a radius of about 0·79 A.; their fourth ionization potentials are 34 V. and 31 V., respectively. Hence, as it requires more energy to remove the first 4*d* electron from outside the 36-electron krypton core than to remove the first 5*d* electron from outside the 68-electron hafnium core, giving in each case a cation of equal charge and radius, shielding in Zr^{4+} is apparently less efficient than in Hf^{4+}. It will become evident later that, although the ionization potential difference is 3 V. in this pair as compared with 2½ V. for the pair Na^+ and Cu^+, the shielding efficiency difference between Zr^{4+} and Hf^{4+} is much smaller than in the pair Na^+ and Cu^+.

In the above examples, radius and charge are the same for the constituents of each pair and nothing can be concluded about how the shielding efficiency in Na^+ compares with that in Zr^{4+}, where both radius and charge differ. Consider first the relationship between r and I when charge is kept constant. Attention has been directed[3] to the fact that the relationship

$$I \propto 1/\sqrt{r} \quad (\text{or } I^2 \propto 1/r) \qquad (1)$$

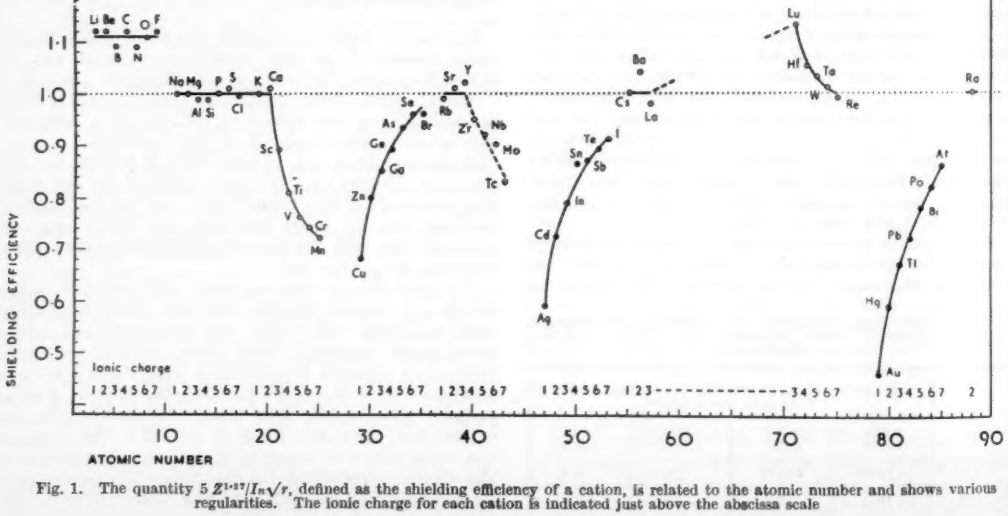

Fig. 1. The quantity $5\,Z^{1\cdot27}/I_n\sqrt{r}$, defined as the shielding efficiency of a cation, is related to the atomic number and shows various regularities. The ionic charge for each cation is indicated just above the abscissa scale

is quite closely followed by the 8-electron groups, Na^+, K^+, Rb^+, Cs^+, and Mg^{2+}, Ca^{2+}, Sr^{2+} and Ba^{2+}. Neither the 2-electron cations, Li^+ and Be^{2+}, nor the 18-electron cations Cu^+, Ag^+, Au^+ and Zn^{2+}, Cd^{2+} and Hg^{2+}, fit the above general relationship. Attention has also been directed[2] to the smooth inverse regularities which exist between r and I_n in such sequences as $Li^+ \rightarrow F^{7+}$; $Na^+ \rightarrow Cl^{7+}$; $K^+ \rightarrow Mn^{7+}$; $Cu^+ \rightarrow Br^{7+}$; $Ag^+ \rightarrow I^{7+}$, etc. Combination of such a regularity for the sequence $Na^+ \rightarrow Cl^{7+}$ with the above inverse-square relationship yields

$$\sqrt{r} \propto Z^{1.27}/I$$
$$\text{or } \sqrt{r}I = K\,Z^{1.27}, \qquad (2)$$

where Z is the ionic charge. With I in volts and r in A., K is found to be $5{\cdot}00 \pm 0{\cdot}01$. The extent to which this relationship is obeyed by non-transitional type 8-electron cations may be observed from Table 1.

It is suggested that the quantity $5\,Z^{1.27}/\sqrt{r}I$ be used as a measure of the shielding efficiency of cations, and those cations which obey equation (2) and therefore have $S_{eff} = 1{\cdot}00$ (Table 1) will be defined as having normal shielding efficiency.

Table 2 gives values of S_{eff} for cations arranged according to the Periodic Table, whereas Fig. 1 relates S_{eff} to atomic number in consecutive sequences.

The plotted points of highly charged cations in Fig. 1 do not correspond exactly with those of Table 2, as they had been calculated on the basis of a value of 1·26 for the charge exponent and not 1·27. As the differences are insignificant with regard to the various regularities of Fig. 1, it has not been redrawn.

S_{eff} either remains uniform ($Li^+ \rightarrow F^{7+}$, and $Na^+ \rightarrow Cl^{7+}$) or varies regularly toward or away from a value of unity. Entry of 3*d* electrons in particular, and 4*d* and 5*d* to a lesser extent, causes a lowering in the shielding efficiency as defined: the effect increases with charge. The reverse developments take place after completion of the 18-electron shells; and in the sequences $Cu^+ \rightarrow Br^{7+}$, $Ag^+ \rightarrow I^{7+}$ and $Au^+ \rightarrow At^{7+}$, S_{eff} increases with charge and tends to approach unity in each case. The effect of entry of 4*f* electrons is apparently unique, and thus the third ionization potentials of lanthanum and lutetium are almost identical (19 V.); the radius decreases from 1·15 A. to 0·85 A. and hence S_{eff} increases from about unity to 1·14, a maximum value which is apparently very similar in magnitude to that of the 2-electron cations. (The third ionization potentials of Ce^{3+} . .Yb^{3+} are not known.) S_{eff} reaches its minimum (0·46) in Au^+.

Some ionization potentials are not accurately known (for example, the sixth of tungsten, the seventh of rhenium, astatine, manganese as well as a few others), but their magnitudes are apparently reliable and serve satisfactorily to reveal the main regularities of Fig. 1.

It should be recalled that the radii of Li^+, Na^+, K^+, Rb^+, Cs^+, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Ra^{2+}, Y^{3+}, and La^{3+}, are virtually identical with those which may be obtained from internuclear distance measurements in dominantly ionic crystals, and that the others may be derived from them either by calculation[1] or from smooth extrapolations[2]. Thus, although the absolute magnitudes of the radii considered here may not have significance other than for investigations on ionic crystals, it is believed that their relative radii are usually accurately known, and this fact may well be of physical significance. A systematic increase of, say, 50 per cent in all the radii would in no way affect the general regularities which have been noted here (Fig. 1).

Discussion in this communication has been restricted to a suggested definition and measure of shielding efficiency; but its possible significance for determining a variety of physical and chemical properties of elements and their compounds will be discussed elsewhere, together with a detailed account of periodic variations between r, I and Z. The significance of ionization potentials in some of these respects has been noted[2–4]. Some examples of properties which might be determined at least in part by shielding efficiency and which will be considered are: atomic volume, metallic properties of manganese as compared with chlorine and bromine as gases, refractive indices and melting points of ionic compounds, structures of metal – non-metal compounds which have low co-ordination, ability of cations to form complexes in solution and the stability of such complexes, stability of bonds in general, heats of hydration, behaviour of cations in fractionated silicate melts, etc. [May 20.

Table 1. CALCULATED VALUES OF K and S_{eff} (for definition see text)

	$Z^{1.27}$	r (A.)	I_n* (V.)	K	S_{eff}
Na^+	1	0·95	5·12	4·99	1·00
Mg^{2+}	2·41	0·65	15·0	5·01	1·00
Al^{3+}	4·03	0·51	28·5	5·05	0·99
Si^{4+}	5·82	0·42	45·2	5·05	0·99
P^{5+}	7·72	0·35	65·0	4·98	1·00
S^{6+}	9·73	0·30	88·1	4·97	1·005
Cl^{7+}	11·83	0·27	114·3	5·00	1·00
K^+	1	1·33	4·34	5·01	1·00
Ca^{2+}	2·41	1·01†	11·9	4·96	1·01
Rb^+	1	1·46	4·17	5·03	0·99
Sr^{2+}	2·41	1·18†	11·0	4·95	1·01
Cs^+	1	1·66	3·89	5·01	1·00
Ba^{2+}	2·41	1·34	10·0	(4·80)‡	(1·04)
Ra^{2+}	2·41	1·43	10·1	4·98	1·00
			Av.	5·00	1·00

* All ionization potentials from Landolt-Bornstein, 6 Auflage, 1 Band, 1 Teil (Atome-Ionen) (Springer, 1950).

† These radii are slightly greater than those given by Pauling (ref. 1) and Ahrens (ref. 2), in accordance with fairly definite evidence from internuclear distance measurements in alkaline earth fluorides and oxides.

‡ Omitted from calculation of the average.

Table 2. SHIELDING EFFICIENCY OF CATIONS

Li^+ 1·12	Be^{2+} 1·12	B^{3+} 1·10			C^{4+} 1·13	N^{5+} 1·10	O^{6+} 1·12	F^{7+} 1·13
Na^+ 1·00	Mg^{2+} 1·00	Al^{3+} 0·99			Si^{4+} 0·99	P^{5+} 1·00	S^{6+} 1·005	Cl^{7+} 1·00
K^+ 1·00	Ca^{2+} 1·01	Sc^{3+} 0·90			Ti^{4+} 0·82	V^{5+} 0·77	Cr^{6+} 0·74	Mn^{7+} 0·71
Cu^+ 0·68	Zn^{2+} 0·80	Ga^{3+} 0·86			Ge^{4+} 0·90	As^{5+} 0·96	Se^{6+} 0·97	Br^{7+} 0·98
Rb^+ 0·99	Sr^{2+} 1·01	Y^{3+} 1·03			Zr^{4+} 0·96	Nb^{5+} 0·93	Mo^{6+} 0·92	Tc^{7+} 0·85
Ag^+ 0·59	Cd^{2+} 0·725	In^{3+} 0·80			Sn^{4+} 0·86	Sb^{5+} 0·88	Te^{6+} 0·91	I^{7+} 0·93
Cs^+ 1·00	Ba^{2+} 1·04	La^{3+} 0·99	Lu^{3+} 1·14		Hf^{4+} 1·06	Ta^{5+} 1·04	W^{6+} 1·02	Re^{7+} 1·00
Au^+ 0·46	Hg^{2+} 0·61	Tl^{3+} 0·70			Pb^{4+} 0·75	Bi^{5+} 0·81	Po^{6+} (0·86)	At^{7+} (0·90)
	Ra^{2+} 1·00				Th^{4+} 0·98			

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LETTERS TO THE EDITORS

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Longitudinal Distribution of Organic Components of Bone

Previous workers[1] have published results on the variation of nitrogen, collagen and phenolic material along long bones. The variation has now been determined of nitrogen, hydroxyproline, tyrosine, hexose and glycogen.

The femur of a freshly killed eighteen months old male goat was sawn into sections as indicated in Fig. 1 and the epiphyseal plates dissected out. The trabecular sections were sampled well away from the periphery of the bone, freed from blood by washing in a high-pressure water jet and from fat by 48 hr. ether extraction. The shaft sections were well scraped inside and out after the marrow had been scooped out. Ether extraction was unnecessary as the shaft bone contained an insignificant amount of ether-extractable material. The sections were crushed to finer than 100-mesh in a steel hammer mill. All results are in mgm./gm. dry weight, moisture being determined by heating to 105° for 16 hr. and weighing after cooling in a desiccator.

Hexose was determined by a modification of Morris's anthrone method[2]. Bone powder containing 50–100 μgm. equivalent of galactose was weighed and transferred to a 24 mm. × 150 mm. test-tube. 2 ml. of water and 4 ml. freshly prepared anthrone reagent were added, the latter from a broad-tipped pipette. The tube was shaken and stood in a 95° water-bath for 15 min. After cooling and centrifuging, the supernatant was read against a standard galactose solution at 620 mμ. Duplicates agreed to within 2 per cent and recovery of added glucose, galactose or mannose was 98–101 per cent. Glucuronolactone, glucosamine and an artificial gelatin hydrolysate even in concentrations much higher than those occurring in bone neither gave any colour nor did they affect the colour given by hexose. Tryptophan gives a colour with anthrone[4] but is only present in collagen in negligible amount[5]. 100 μgm. galactose or mannose gave a colour density equal to that given by 55 μgm. glucose. In view of the isolation of a galactose–mannose containing polysaccharide from bone[2], results are given as galactose equivalents.

For determination of glycogen, 0·1–0·5 gm. bone was shaken with 5 ml. 30 per cent potassium hydroxide in a 95° water-bath for 1½ hr., making up to volume occasionally with water. The freed glycogen was precipitated and determined essentially as described by Ellis *et al.*[6]. Recovery of glycogen added to bone powder was 85 per cent. Results have been corrected to allow for this.

Hydroxyproline, tyrosine and nitrogen were determined on 6 *N* hydrochloric acid hydrolysates (48 hr., 105°), the acid being removed by repeated evaporation to dryness in a vacuum desiccator. Hydroxyproline was determined by the method of Neumann and Logan[7], tyrosine by that of Udenfriend and Cooper[8] and nitrogen by a micro-Nessler method[9].

The general level of organic components is low in the shaft, rising toward the epiphyses. Collagen and total nitrogen were found to have this type of distribution by previous workers[1]. The galactose curve suggests that non-chondroitin-like polysaccharide material is present, the amount of which is markedly high in the epiphyseal plate. Glycogen varies in a similar manner but at a far lower level. No chemically determined figures for bone glycogen have come to my notice except those of Leynse[10] on rabbit, rat and cat long bones. His results are higher than these, but were obtained on very young animals. Glock[11], using a histological method, finds the glycogen content of rat long bones to decrease sharply with age after the tenth day, becoming about 0·5 mgm./gm. after the fortieth day.

The hydroxyproline curve gives a measure of collagen content probably more significant than previous results based on autoclave soluble-nitrogen determination. The epiphyseal plates do not have a markedly different hydroxyproline content from the other epiphyseal and metaphyseal sections. The nitrogen/hydroxyproline curve suggests the presence of relatively high amounts of non-collagen protein in the epiphyseal plates and proximal metaphyseal trabeculæ. It must be borne in mind that material similar to the alkali-soluble collagen precursor

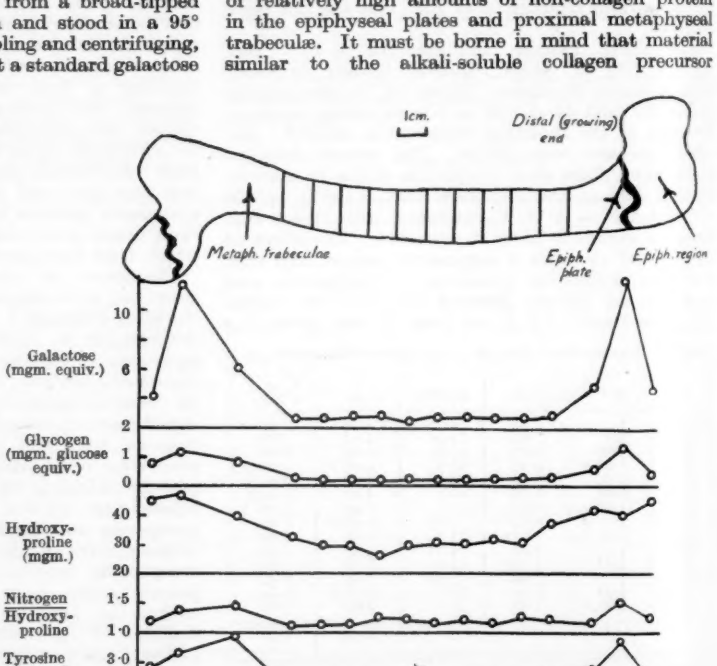

Fig. 1. Longitudinal distribution of organic components in goat femur. Values are in mgm./gm. dry bone powder. Galactose equivalent values do not include glycogen

extractable from skin is very possibly present in relatively high amounts in the metabolically active epiphyseal and metaphyseal areas. As this has a rather higher hydroxyproline and rather lower tyrosine content than collagen as a whole[12], its presence would tend to obscure the contribution of non-collagenous protein, high in tyrosine and without significant hydroxyproline to those areas.

Determination of phenolic material by the Folin–Ciocalteau method[1b], on the above and other bones, gave tyrosine equivalents up to 30 per cent higher than those obtained using the more specific method for tyrosine of Udenfriend and Cooper. Thus the presence of small amounts of non-tyrosine phenolic material is indicated.

The results are in general agreement with a previous less-detailed series of determinations carried out on an eighteen months goat ulna.

I thank Dr. J. Eastoe, Dr. H. J. Rogers and Dr. T. F. Dixon for discussing this work with me, and the latter also for suggesting its subject. I also thank Mrs. N. Mendlesohn for the nitrogen determinations.

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Maternal Effect on Birth Weight in South Devon × Dexter Cattle Crosses

In reciprocal crosses between the Shire horse and Shetland pony, representing respectively extremes in large and small breeds, Walton and Hammond[1] demonstrated that the size of the offspring at birth and the placental weight are directly proportional to the size of the dam, and not simply intermediate between the sizes of the parent breeds. Hammond[2] postulated that the limitation of size in the cross-bred fœtus carried in the small mother is possibly brought about by a higher rate of metabolism of maternal tissues, as compared with a lower rate in the large breed. Otherwise, it was argued, special growth substances of maternal origin may be involved.

This approach to the study of factors controlling birth-weight has been followed up with various other types of mammals[3–5]; but the conclusive results obtained from the equine crosses were not achieved. It seems, therefore, that certain factors are responsible for the manifestation of a decided maternal influence, of which the length of gestation and the extent of the differences between the two parent breeds are perhaps the most important. In multiparous animals, furthermore, the maternal influence may be obscured by variations in litter size.

Though in cattle it is not possible to obtain breed differences as great as those available in the horse, we possess an animal with a long gestation period which should promote expression of a maternal effect, if present at all. Observations made during cross-breeding experiments between Holstein-Friesian and Jersey cattle at Beltsville, United States[6], however, revealed no significant differences between either of the reciprocal cross-bred offspring, or the mean of the birth-weight averages for the parent breeds. On the other hand, results of experiments in progress in South Africa[7], where Afrikaner (cows averaging 1,002 lb.) and N'guni (cows averaging 740 lb.) cattle are reciprocally crossed, provide at least some evidence of such an influence.

To gain further information on this subject in the bovine, three South Devon heifers were inseminated with deep-frozen Dexter semen, and three Dexter females similarly with semen from a South Devon bull. The difference in size between these two breeds can be judged from the illustrations, reproduced to scale, shown in Fig. 1 (*a*). Following conception, the animals received routine farm treatment, but were brought under shelter a few days prior to calving to make possible close observation. As soon as the calves were sufficiently dry after birth, weights and body measurements were recorded, while photographs were taken within twenty-four hours post-partum. The results obtained are summarized in the accompanying table; differences in size between the reciprocal crossbred calves at birth are illustrated by the scale photographs shown in Fig. 1 (*b*).

	Calves out of: South Devon dams	Dexter dams	Difference
No. of observations	3	3	—
Age of dams at calving (months)	35·7	42·0	6·3
Gestation period (days)	290·3	278·0	12·3
Weight of dams, pre-partum (lb.)	1158·7	614·0	544·7
Weight of dams, post-partum (lb.)	1031·7	535·3	496·4
Weight lost (lb.)	127·0	78·7	48·3
Weight of calves at birth (lb.)	72·0	57·5	14·5
Weight of placenta (lb.)*	10·6	3·2	7·4

* Two observations only for each group

The South Devons, all three maiden heifers, consisted of a fairly homogeneous group regarding both size and breeding, and calved at much the same age. Though also closely related, only two of the Dexter females were first calvers, the third being an older cow with two previous pregnancies. Differences in age within the latter group also accounted for a larger variation in weight. The mothers were all weighed within a day or two before calving, as soon as signs of parturition became apparent. The post-partum weight was recorded within forty-eight hours following calving. This latter figure, in particular, serves as an indication of differences in size between the two parent breeds, namely, the larger breed was nearly twice the size of the smaller.

The mean birth-weight for the calves out of South Devon mothers truly reflects the range encountered. Considering 94·5 lb. as a reliable birth-weight for pure-bred South Devon calves (out of first-calf mothers[8]), it is clear that the size of the cross-

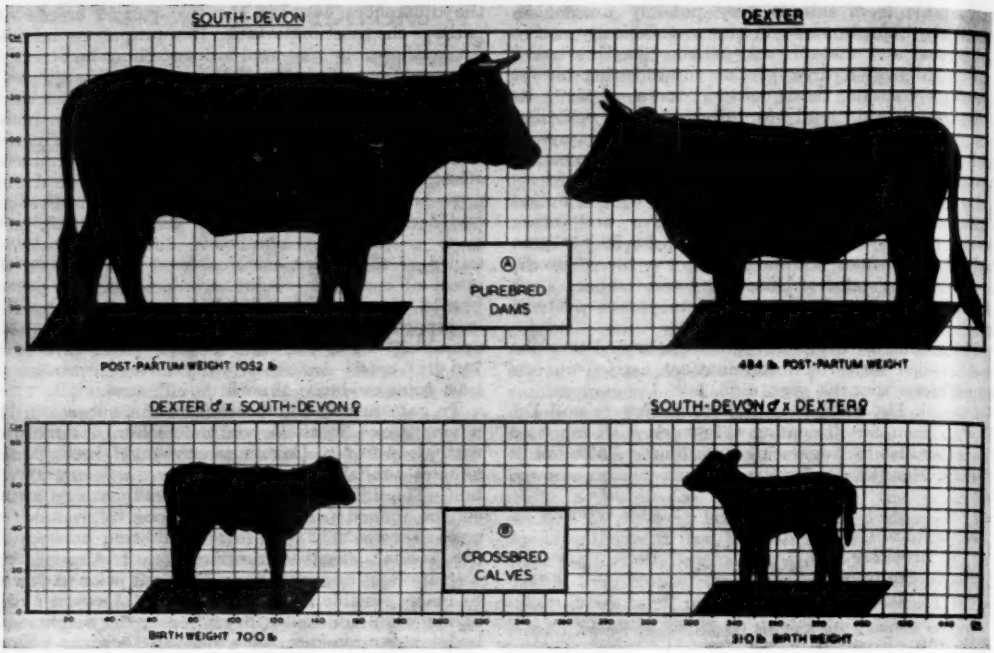

Fig. 1

bred offspring, though failing to attain the pure-bred weight, was favourably influenced by the larger uterine environment. The rather prolonged gestation, compared with that of their reciprocal crosses, also indicates that there was a decided effort to reach maximum size at birth, especially in view of the fact that parturition normally occurs at a time when the fœtus approaches a size characteristic of the species and is still able to pass through the genital passage.

The cross-bred calves out of Dexter mothers were larger (57·5 lb.) on an average than the Dexter breed mean of 52·3 lb.; but the effect of restricted uterine space nevertheless is apparent. The average value, though probably a true reflexion, is, however, composed of a rather wide variation ranging from 40·5 to 81·0 lb. The smaller calf was produced by a small (352 lb.) two-year-old heifer, in fact too small to deliver a calf even of that size. Though the small dam severely limited overall size of the fœtus, the early maturing fœtal head had much the same proportions as that of a calf 12–15 lb. larger, which made a normal parturition impossible. The large birth-weight of the latter individual may be explained by the more advanced age (6 yr.) and greater size (770 lb.) of the mother. Furthermore, the mother had the advantage of abundant early summer grazing during late pregnancy which was not available to any of the other cows included in the study.

Expressing the birth-weight of the calf as a percentage of the weight lost during parturition, striking differences are revealed. Calves out of South Devon dams constituted 56·7 per cent of the total loss, compared with 73·1 per cent for calves out of Dexter dams. Hence, in the event of a restricted uterine environment, the fœtus receives preference over development of accessory tissues and fluids, rather similar to the effect of a low nutritional plane[9]. This fact was substantiated by the placental weights. Not only is the placenta smaller in absolute measure in the case of the small calf, but it is also relatively smaller. The placenta expressed as a percentage of the birth-weight equals 14·5 and 7·1 per cent respectively for the large and small reciprocal crosses.

When mating a large bull to a small cow, provided the mother is normally developed for her age, the results indicate that the smaller maternal environment should restrict fœtal size sufficiently for parturition to be possible. On the other hand, in the case of an inter-breed crossing in which the mother is the larger parent, she will exercise a beneficial influence on the offspring, at least so far as size at birth is concerned. It is hoped that the investigation may be continued to study post-natal growth to determine whether this advantage is still manifested during later life.

Our thanks are due to Mr. L. E. Rowson, Agricultural Research Council Unit of Reproduction, for performing the inseminations and for veterinary attention, and also to Mr. G. Pluck and staff members of the Animal Research Station, Cambridge, for assistance with the experimental animals.

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Determination of Lactic Acid in Cultures of Lactobacilli

THE technique of Barker and Summerson[1] for the determination of lactic acid in blood has been successfully applied to the determination of this acid in silage[2,3] and in milk[4]. During the course of work which is being carried out jointly in these laboratories and in those of the Department of Bacteriology, Edinburgh and East of Scotland College of Agriculture, on the formation of lactic acid and volatile fatty acids in cultures of lactobacilli, it became clear that the results obtained by the above technique were unsatisfactory. For example, extremely high 'blanks' were given by the culture medium itself, and it was found impossible to obtain replicate results with samples of the same cultures. Various dilutions of the uninoculated medium were tried and it was found that even at high dilution substantial development of colour occurred. This was originally thought to be due to the high glucose content of the medium (5 per cent w/v); but, again at high dilution, this seemed unlikely. The possible answer may lie in factors involved in the yeast extract incorporated to the extent of 0·5 per cent w/v in the medium.

Recourse was made to the method of Long[5], which has been found to be wholly satisfactory for the present purpose. The method as used here is as described in the original paper, except that 0·1–0·2 ml. of culture fluid is introduced into the thistle funnel of the apparatus and is washed into the distillation tube with 4 ml. of water. Where very large amounts of lactic acid are present, it is advisable to dilute an aliquot of the culture by 10 and to use 0·2 ml. of the diluted fraction. From recovery experiments (Fig. 1) it would appear that material containing considerably larger quantities of lactic acid than those suggested by Long may be successfully handled. The general run of all experiments has indicated a recovery of lactic acid varying between the limits of 95·5 and 103 per cent.

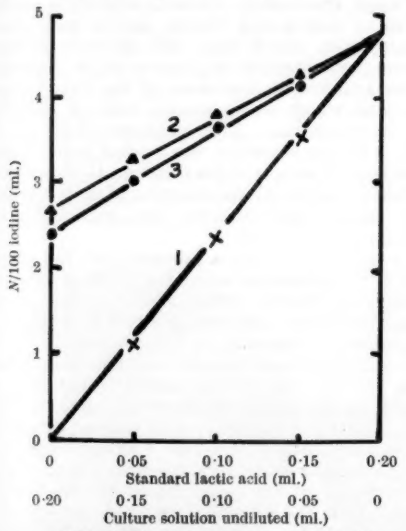

Fig. 1. Recovery of lactic acid: (1) from 0–0·20 ml. of standard (1·20 gm. of acidified lithium lactate/100 ml.); (2) from mixtures of lactate standard and added amounts of culture of lactobacillus (homofermentative strain at 30° for 12 hr.); (3) as in (2), using a heterofermentative strain grown at 45° for 72 hr.

A full account of the results obtained in the study of acid formation in cultures of lactobacilli will be published elsewhere.

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Interference and Cell Protection by Poliomyelitis Virus in Tissue Culture

RECIPROCAL interference between strains of the three recognized types of poliomyelitis virus has been reported by Ledinko[1], using roller-tube cultures of monkey testicular tissue. In her experiments, both the 'interfering' and the 'excluded' virus were fully cytopathogenic, and there was no suggestion of any mutual inhibition of their degenerative effects on the cells. Prevention of growth of the second virus, as shown by titration in the presence of type-specific antiserum against the first, was apparently the result of pre-emptive infection and subsequent destruction of susceptible cells by the first virus. The purpose of this communication is to describe a further example of interference among poliomyelitis viruses, in which a more direct recognition of the effect was made possible by the peculiar cytopathogenic behaviour of the interfering virus.

Roller-tube cultures of rhesus monkey kidney were used. Pieces of minced tissue, about 1 mm. in diameter, were stuck to the glass with a thin plasma clot and grown in 2 ml. of a medium consisting of the synthetic mixture 199[2] with 5 per cent of heated horse serum and 1 per cent of chick embryo extract. After eight days, most of the explants had produced an epithelial-cell outgrowth of about 5 mm. radius. At this time the medium was replaced by 2 ml. of mixture 199 and the cultures were ready for infection.

During the second and third passage in such cultures of the newborn mouse-'adapted' MEF_1 strain of Type 2 poliomyelitis virus[3], a characteristic picture was seen by the fifth day after inoculation: most of the affected cells were already in advanced decay and coming off the glass; yet around each explant there remained an island—1–2 mm. in radius—of healthy looking cells. The edge of these islands was quite sharply defined and picked out by a 'tide-mark' of degenerating cells and cell debris, as shown in the accompanying photograph. Slowly, the more outlying cells became increasingly granular, and degeneration progressed towards the explant. Finally, between two and three weeks after infection of the culture, the explant disintegrated and its dependent sheet broke up into individual cells, which before long were destroyed.

Cultures infected five days earlier with approximately a hundred cytopathogenic doses (TCD_{50}) of third-kidney-passage MEF_1 virus were re-inoculated, after renewal of the medium, with 100 TCD_{50} of either Mahoney (Type 1), *Y-SK*, *MIN* (both Type 2) or Saukett (Type 3) strains of poliomyelitis virus, all producing rapid and complete degeneration of outgrowth and explant in cultures of monkey kidney. A cytopathogenic strain of Coxsackie virus was also

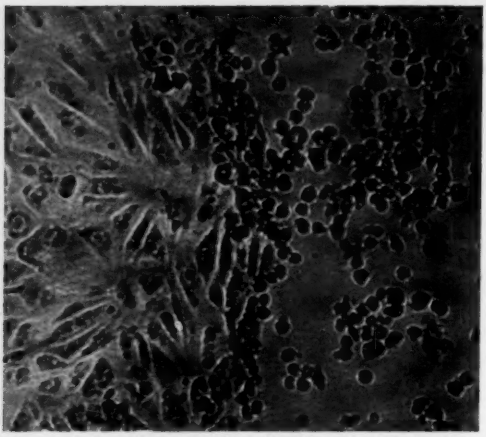

Fig. 1. Culture of monkey kidney five days after infection with *MEF*$_1$ virus. (The ocular was × 10, the objective × 5.) The explant is out of the picture to the left. Photograph taken by Mr. W. Clifford

tested. Similar cultures, but uninfected with *MEF*$_1$ virus, were inoculated as controls.

Within the first two days after superinfection, no obvious change was noted in the cell-islands, whereas the control cultures had by then almost completely degenerated. Thereafter, marginal degeneration of the islands began again and proceeded as in the *MEF*$_1$ controls, or more rapidly. It was clear, however, that those cells which had weathered the initial *MEF*$_1$ attack had been temporarily spared from the destructive action of the other four strains of poliomyelitis virus and the strain of Coxsackie virus.

Sabin, Winsser and Hennessen[4] reported that large doses of *MEF*$_1$ virus of the 134th baby-mouse passage produced no degeneration in cultures of cynomolgus monkey kidney, but that several blind passages yielded cytopathogenic virus. Lines of low or absent, and of high, cytopathogenicity have since been separated (Sabin, personal communication) and it has been found possible to titrate the first virus thanks to its blocking of the degeneration produced by the second.

In previously reported examples of interference between animal viruses in tissue culture, the demonstration of an interfering effect has depended on subtitrations of the second virus either in animals or in further tissue cultures. The observations of Sabin and his colleagues and those now reported are concerned with the direct, microscopic detection of virus interference, as seen in the exposed cells. To these cells the first virus, having forestalled the second, has given a definite, if transient, protection by virtue of its presence and activity at the surface or in the interior of the cell, or by some other means unknown.

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Biogenesis of Hyoscyamine

The biogenetic origin of the tropane bases has recently been the subject of some discussion[1,2], Mortimer[1] suggesting that the tropane skeleton may be derived from the breakdown products of tryptophan metabolism. This novel idea is contrary to the accepted hypothesis that a base such as tropine is produced *in vivo* by reactions analogous to the *in vitro* synthesis[3] of tropinone from succindialdehyde, methylamine and acetone. The succindialdehyde is considered to be a metabolite of ornithine, and James[4] showed that significant increases in the amount of hyoscyamine in *Atropa belladonna* occurred following the feeding of arginine or ornithine.

We have tested this hypothesis by feeding radioactive ornithine to mature *Datura stramonium* plants which produce hyoscyamine and hyoscine. [α-^{14}C]-Ornithine hydrochloride with an activity of $4{\cdot}8 \times 10^7$ disintegrations/min./m*M* was administered to the plants by addition to the aerated nutrient solution in which the roots were growing. After a week, almost all the activity had disappeared from the nutrient solution and was translocated throughout the plant. The crude alkaloids were obtained from the dried plants by standard methods[5]. Paper chromatography of the alkaloids showed radioactivity to be present in the spot corresponding to hyoscyamine, but little or none to be present in that corresponding to hyoscine. The alkaloids were separated on a 'Celite' column[6] yielding pure hyoscyamine aurichloride with a specific activity of $1{\cdot}08 \times 10^6$ disintegrations/min./m*M*. The hyoscine obtained from the column was inactive. The radioactive hyoscyamine was degraded to locate the positions of activity. Alkaline hydrolysis gave active tropine and inactive tropic acid. Oxidation of the tropine with a mixture of chromic and sulphuric acid[7,8] gave N-methyl-succinimide, which had the same specific activity as the hyoscyamine. Reaction of the imide with phenyl magnesium bromide according to the procedure of Lukeš and Prelog[7] gave 1-methyl-2,5-diphenylpyrrole, which was oxidized with aqueous potassium permanganate to give a mixture of inactive oxalic acid (from the β-carbons of the pyrrole) and benzoic acid which had a specific activity half that of the hyoscyamine. This indicated that all the activity in the hyoscyamine was present in the bridge-head carbons (1 and 5) of the tropine. It thus follows that ornithine is indeed the precursor of the pyrrolidine ring of tropine and renders very improbable the speculations of Mortimer[1].

Previous work in these laboratories[5] has shown that [1,4-^{14}C]-putrescine when fed to *D. stramonium* at a stage of growth corresponding to that in the present experiments did not give rise to radioactive hyoscyamine. Putrescine is thus apparently ruled out as an intermediate between ornithine and tropine, and its presence in various plants would seem to represent an alternative pathway of ornithine metabolism. The work of James[10] with enzyme extracts of belladonna indicates that α-keto δ-amino-valeric acid is a probable intermediate in the synthesis of tropine, the δ-nitrogen of this acid becoming the tropine nitrogen. Thus the present experiment with [α-^{14}C]-ornithine would be expected to yield tropine labelled on only one of the bridge-head carbons; however, the symmetry of the molecule renders it impossible to differentiate between the two bridge-head carbons by chemical methods.

Since no activity was found in the hyoscine, it would seem that tropine is not a precursor of scopine. It is possible that it is produced from a hypothetical hydroxy-ornithine which could conceivably be obtained from hydroxyproline.

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Electrophoretic Migration of Contents of Intact Liver Nuclei

During attempts to separate rat liver nuclei from fragments of cell membrane by electrophoresis, we have observed movement of the nuclear contents, the nuclei remaining stationary.

The nuclei were obtained by homogenization of fresh rat liver in a glass tube with stainless steel non-rotating conical plunger. The suspending fluid was either 0·29 *M* sucrose or 3·3 *M* glycerol, with the addition of 0·01 *M* sodium chloride or of 0·001 *M* calcium chloride; in the latter case the free calcium concentration was theoretically maintained at this value by the addition of 0·0025 *M* dipotassium salt and 0·0075 *M* potassium calcium salt of nitrilotriacetic acid. The *p*H was adjusted to 6·9, or, in a few cases, to 8·0, with 0·003 *M* barbitone buffer. The nuclei were partially freed of whole cells and mitochondria by centrifugation, and then observed in a modified Abramson[1] micro-electrophoresis cell, under a phase-contrast microscope.

When potential gradients of 10 V./cm. and above were applied, the nuclei remained stationary; but the nuclear contents, including the nucleoli, moved to the side of the nuclei towards the anode (Fig. 1). This produced a half-dark, half-light appearance of the nucleus, called for convenience an 'eclipse'. If after a few seconds the current was switched off, the contents flowed back to their original position, and the normal appearance was restored. However, after several repetitions of this procedure with higher potential gradients (50 V./cm.) the 'eclipses' became irreversible and persisted on switching off the current; this irreversibility was sometimes accompanied by shrinkage and appearance of granularity in the nuclei. The 'eclipses' were seen at *p*H 6·9 and 8·0, and at both *p*H's and in all the media used red cells and bacteria moved immediately and rapidly towards the anode and cathode respectively, and stopped directly the current was switched off.

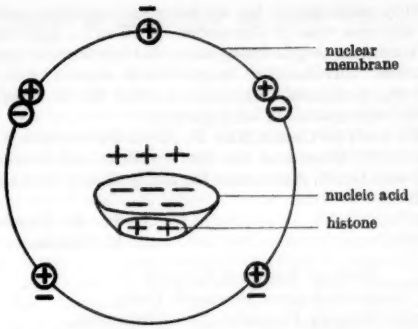

Fig. 2. Diagrammatic interpretation of electrophoretic behaviour of nucleus

An attempt was made to increase the net negative charge on the nucleus as a whole, and so to make it move, by addition of potassium polymethacrylate to a final concentration of 0·0002 *M* (about a fifth of the concentration required to release nucleic acid from combination with histone). There was some suggestion that in this medium 'eclipses' were formed less readily, and that the nuclei moved slowly towards the anode. However, the results were not clear-cut.

An interpretation of the 'eclipse' phenomenon is expressed crudely in Fig. 2. The plus and minus signs represent ions, of which the encircled ones are imprisoned either inside the nucleus or on the nuclear membrane, whereas the unencircled ones can move freely through the nucleus and its membrane. The imprisoned ions are shown predominantly negative within the nucleus and positive on the membrane, the totals being equal, in order to explain the non-migration of the whole nucleus and the anodic migration of the contents. The net negativity of the contents could be due to a slight predominance of nucleic acid over histone in the nucleoprotein, whereas the unused histone might perhaps be responsible for the net positivity of the membrane.

The above experiment shows that the contents of reasonably undamaged resting nuclei have a high electrophoretic mobility, and is of interest in connexion with the question whether movement of chromosomes during anaphase can be electrophoretic. The potential dif-

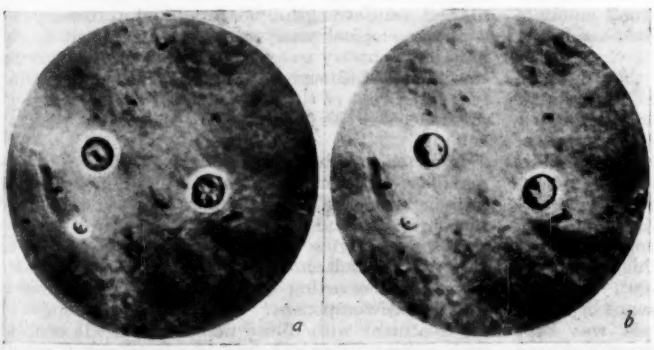

Fig. 1. (*a*) Liver nuclei. (*b*) The same under potential gradient of 38 V./cm. Note anodic migration of nuclear contents including nucleoli. The anode is on the left

ference maintained by us between opposite poles of the nucleus was of the order of 10 mV., and caused the contents to pile up against the membrane in a few seconds. Chromosome migration is slower than this, and the potential difference needed for it should be easily maintainable biologically.

We wish to thank Miss B. Hunt for assistance, the Bersworth Chemical Co. for a gift of nitrilotriacetic acid and Dr. P. Alexander for a gift of polymethacrylic acid.

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Participation of Pyridoxal Phosphate in the Enzymic Synthesis of Serine

Evidence that pyridoxal phosphate is involved in the synthesis of serine by micro-organisms has been provided by Lascelles and Woods[1], who found that incorporation of pyridoxal phosphate in the medium stimulated serine synthesis by washed cells of *Streptococcus faecalis* R. and enabled *Leuconostoc mesenteroides* to grow in the presence of glycine and a CO_2-rich atmosphere instead of serine. Participation of pyridoxal phosphate in serine synthesis in chickens was suggested by the observation that liver extracts from pyridoxine-deficient chickens showed a reduced ability to incorporate [^{14}C]formate into the β-position of serine[2]; but hitherto attempts to demonstrate a direct activation by pyridoxal phosphate of serine synthesis by liver extracts have been unsuccessful[3].

The role of pyridoxal phosphate in serine synthesis has been further studied with an enzyme preparation which was extracted from acetone-dried rabbit liver powder and partially purified by heat treatment and ammonium sulphate fractionation at *p*H 7·5. The enzyme was incubated with glycine, formaldehyde, tetrahydropteroyl glutamic acid (tetrahydroPGA) and bicarbonate buffer, *p*H 7·2, at 37° for 1 hr. Serine was determined by manometric estimation of the carbon dioxide produced by periodate oxidation. A control in which tetrahydroPGA was omitted provided an adequate correction for small amounts of carbon dioxide produced by periodate oxidation of material other than serine.

Addition of pyridoxal phosphate to the otherwise complete system appreciably increased the rate of serine synthesis, increments of more than 100 per cent being sometimes obtained in the presence of 5×10^{-4} *M* pyridoxal phosphate. Although added pyridoxal phosphate consistently increased serine synthesis by these enzyme preparations, they nevertheless exhibited considerable activity in the absence of added pyridoxal phosphate. Prolonged dialysis, even after subjecting the enzyme to high salt concentrations at temperatures up to 60°, did not significantly reduce the activity in absence of added pyridoxal phosphate, provided the *p*H was kept within the limits 5·0–7·5. After the enzyme had been incubated for 30 min. at *p*H 8·6 and 37°, however, it was almost inactive for serine synthesis. An enzyme preparation so treated could be largely reactivated for serine synthesis by incubation with pyridoxal phosphate at *p*H 7·2 and at 37° prior to addition of substrates. The degree of reactivation increased as the period of incubation of the enzyme with pyridoxal phosphate was increased up to 2 hr. Under these conditions serine synthesis with the pyridoxal phosphate-reactivated enzyme was up to one hundred times greater than that with the inactivated enzyme.

Similar though less striking effects of pyridoxal phosphate on serine breakdown were also observed, both with normal and inactivated enzyme preparations. The reaction was in this case followed by measuring formaldehyde produced by the enzyme from DL-serine[4].

A more detailed report of this work will be published elsewhere.

I wish to thank Prof. A. H. Ennor for helpful advice and Mr. T. Curtis for technical assistance. I am indebted to Dr. A. L. Morrison of Roche Products for a gift of crystalline pyridoxal phosphate.

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The Precursor of 2-Carboxy-Pyrrole in Mucoproteins

We have previously reported[1] the isolation of a pyrrole derivative from the alkaline hydrolysate of bovine submaxillary gland mucoprotein and its identification as 2-carboxy-pyrrole (III). On reduction it yielded 2-carboxy-pyrrolidine (proline), chromatographically it showed the same behaviour as synthetic III, and it gave in the cold a purple colour with Ehrlich's reagent. Recently, the ultra-violet absorption spectra of both the substance prepared from mucoprotein and synthetic III were found to be identical.

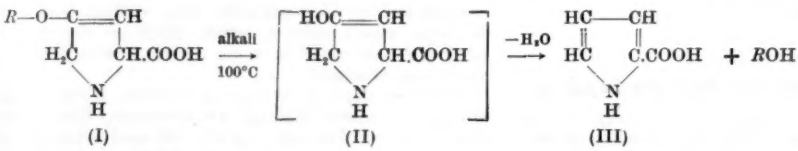
The presence of about 4 per cent of the Ehrlich-reacting substance in the mucoprotein together with the high molecular extinction coefficient of III ($\varepsilon_{max.}$ 256 mμ = 11,118 in phosphate buffer *p*H 7·0, ionic strength 0·05) prompted us to carry out a spectroscopical analysis of the untreated mucoprotein. Contrary to expectation, no peak at 256 mμ was exhibited, though admixture of III corresponding to 2·6 per cent of the dry weight of the mucoprotein present gave rise to an easily detectable peak at 256 mμ.

Like many other mucoproteins, the bovine submaxillary gland mucoprotein inhibits influenza virus hæmagglutination. Interaction between inhibitory mucoproteins and purified influenza virus (or the receptor-destroying enzyme of *Vibrio cholerae*) was shown[2] to result in the liberation of a dialysable compound consisting of a non-amino sugar and a nitrogenous component. The compound decomposed on treatment with dilute mineral acid. It coupled with *p*-dimethylaminobenzaldehyde to give a purple colour even after prolonged treatment with alkali,

though alkali treatment was not necessary for colour formation[3]. These properties strongly suggested the identity of the colour-producing component with III which we had isolated previously from the substrate for the viral enzyme or for receptor-destroying enzyme. When the compound split off from the purified bovine submaxillary gland mucoprotein by action of receptor-destroying enzyme was analysed spectroscopically, no indication for the presence of III was obtained. Upon treatment of the split product with 0·1 *N* sodium carbonate for 10 min. at 100° C., however, an ultra-violet absorption spectrum became apparent practically coinciding with that of synthetic III. Paper partition chromatography of the alkali-treated split product confirmed the presence of III.

It would thus appear that mucoproteins contain an amino-acid which on very mild alkali treatment is readily transformed into III. The possibility that one of the following compounds, glutamine, 2-carboxy-pyrrolidone, 2-carboxy-pyrrolidine, 4-hydroxy-2-carboxy-pyrrolidine (hydroxy-proline), N-acetyl-glucosamine, may be the precursor was examined, but in each case with negative result.

We conclude from these data that the most probable structure of the precursor of III in the biological material tested is 4-hydroxy-2-carboxy-pyrroline (II), stabilized by the engagement of its enolic hydroxyl group in a glycosidic linkage apparently with a pentose (I). The glycosides of enols easily yield to alkali hydrolysis; therefore, mild alkali treatment of I will release II which, being unstable, instantaneously becomes stabilized to III by a shift of the double bond and loss of 1 mol. H_2O.



It seems probable that neuraminic acid ($C_{10}H_{19}O_9N$) prepared by Klenk[4] as its methoxy derivative from bovine submaxillary gland mucin is identical with I ($C_{10}H_{15}O_7N.2H_2O$), and that sialic acid[5] and *lactaminsäure*[6] are closely related to I. On the other hand, Hiyama's[7] claim that a crop of 2-carboxy-pyrrole crystals may be obtained by treating the mucoprotein primarily with 10 per cent potassium hydroxide at 100° C. for 10 hr. could not be substantiated in our laboratory, nor is his interpretation of the origin of III consistent with the above observations.

Details of these results will be published elsewhere.

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Effect of Ephedrine on Dark Vision

The effect of drugs on night vision and dark adaptation is a problem of both theoretical and practical importance which has already received a good deal of attention, particularly during the Second World War. Of the various drugs the effects of which have been investigated systematically, ephedrine has apparently featured in only one experiment, namely, that of Rose and Schmidt[1]. These authors report no significant effect on dark adaptation. Further studies on the influence of ephedrine and other sympathicomimetic drugs are particularly desirable in view of the claims of Babskil[2], Kekcheyev[3] and their associates that the sympathetic nervous system exerts an 'adaptive influence' on the visual analyser, and of recent research at the Institute of Psychiatry which suggests that the impaired dark vision of neurotic patients may be due to sympathetic over-activity. To obtain further information on this point, an experiment was undertaken with four subjects using a test of night visual ability which had previously been shown in several studies to differentiate normal from neurotic groups.

This test involves recognition of the position of a triangular test object against a circular, uniformly illuminated, field subtending about four degrees. Threshold judgments, expressed in grades of brightness, are obtained at four times—three, five, seven and ten minutes—after dark adaptation begins. The criterion of 'success' at a particular level of brightness is two consecutive correct judgments. Although the test makes demands on the subject's dark adaptation, it is more accurately termed a test of visual ability under conditions of low illumination, for it involves factors other than mere light sensitivity.

A four-by-four Latin square design was employed for the experiment, each subject receiving one of four 'treatments' on each of four consecutive days. Treatments were as follows: (1) control; (2) drug (dark vision being tested one hour after the subject had received the drug); (3) drug 1 (test administered one and a half hours after receiving drug); (4) placebo. Ephedrine was given orally, each subject receiving 1 gr.

The resulting table of dark-vision grades for three, five, seven and ten minutes was submitted to analysis of variance to determine the relative effect of the various components, individuals, days and treatments. Results of this analysis show quite clearly that the drug treatment had no significant effect on dark-vision grades. The analysis of variance table for threshold measures at three minutes is reproduced herewith; tables for five, seven and ten minutes are essentially similar in general form. The mean dark-vision grade for control and placebo treatments was 27·65 compared with a mean of 28·34 for the two

Source of variance	Sums of squares	Degrees of freedom	Mean squares
Individuals	75·5	3	25·16
Days	5·5	3	1·83
Treatments	3·0	3	1·00
Residual	11·0	6	1·83
Total	95·0	15	

drug treatments. Day-to-day variation within individuals was not significant.

Taken in conjunction with the results of Rose and Schmidt's experiments on light thresholds, these findings cast some doubt upon the validity of any general hypothesis concerning the positive or negative effect of sympathetic activity on dark vision. They do not, however, necessarily invalidate more specific types of hypothesis. Thus, it is conceivable that ephedrine would exert a significant effect on visual ability during the latter part of the adaptation period. Indeed, closer examination of Rose and Schmidt's results suggests a definite impairment of sensitivity from about 15–40 min. after the beginning of dark adaptation, even though there is no appreciable effect before that time. Although the deviations were not statistically significant according to the tests applied, the consistent trend during the 15–40 min. period points to the need for a repetition of their work and an extension of the present study to include the latter part of the adaptation curve. It is hoped to undertake these further studies as part of a general programme of research on visual and ocular processes in psychiatric patients.

I am indebted to Mr. A. S. C. Ehrenberg, Dr. J. G. Thorpe and Dr. D. S. Troughton for their helpful discussion when the experiment was planned. To Mr. Ehrenberg I am also grateful for the Latin square design.

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Maintenance *in vitro* of *Fasciola hepatica*

A necessary preliminary to a study of the physiology of helminths is their maintenance *in vitro*, a rare accomplishment. Some nematodes and a few cestodes have been maintained for some time with moderate success, and this is also true for certain small trematodes[1], but not for *Fasciola hepatica*. This common liver fluke of the sheep has so far lived *in vitro* only for short periods of about 60 hr. and never more than about three days. These were the best results of experiments[2] in which worms were taken from the livers of cattle or sheep which had been dead for 1–6 hr. and transported from the abattoir to the laboratory in cold bile. Batches of seven to nine worms were then immersed in 500 c.c. of various saline solutions and incubated at 37° C., solutions being changed after 16 hr. and after a further 24 hr. In my opinion, an over-elaborate series of experiments failed because the medium (which contained sodium borate) was unsuitable and the trematodes often moribund at the outset. "Many flukes," we are informed, "never moved in the laboratory except on strong stimulation", and results were collected on the basis of 50 per cent survival. More satisfactory methods of culture will serve to keep worms alive in a state of active movement, and such worms will retain the reddish colour and fleshy appearance which is normal to them.

My own experiments have convinced me that *Fasciola hepatica* will live in Stephenson's 'saline III' for about two days; but that at the end of this period they are in a dying condition. No better results are obtained when any one of several other salines are used as media; but Hédon–Fleig solution has given excellent results. This is a buffered, borate-free medium with the following composition: sodium chloride, 7·0 gm.; potassium chloride, 0·3 gm.; calcium chloride, 0·1 gm.; sodium bicarbonate, 1·5 gm.; disodium hydrogen phosphate, 0·5 gm.; magnesium sulphate, 0·3 gm.; glucose, 1·0 gm.; distilled water, 1,000 c.c. This medium is "very useful for any work on living cells of terrestrial or fresh water invertebrates"[3]. It has been used once before[4] for the culture of a trematode—*Aspidogaster conchicola*, a parasite of freshwater mussels of the genera *Anodonta* and *Unio*; but in this instance it proved to be inferior as a medium to mussel blood or even a crude mixture of the body liquids and the liquid abstracted from the viscera and mantle cavities of the hosts. If we believe that a certain close degree of compatibility exists between the tissues of trematodes and those of molluscs (in which larval trematodes develop), this saline medium is a logical choice, because it serves well for the culture of molluscan tissues.

Be this as it may, Hédon–Fleig solution is far superior to Stephenson's 'saline III' as a medium for *Fasciola hepatica*. Many preliminary experiments of mine have proved that the worms will continue to live in this liquid for more than three days and sometimes for five to six days without loss of movement or natural coloration. Clean methods were used in these experiments, and solutions were changed several times each day; but no attempt was made to obtain sterile cultures. The results have been confirmed by a pupil working under my direction, and a technique has been developed which avoids the contamination of the cultures with certain airborne bacteria which exert a lethal effect on the worms after three or more days, no matter how often solutions are changed.

This technique is briefly as follows. Hédon–Fleig solution is passed through a Gallenkamp filter using a 6 cm. Ford 'Sterimat' (grade *SB*) and a number of 25 c.c. portions are set up in sterile 3 in. × 1 in. tubes, plugged with cotton-wool and set in a water bath until required. Warm livers are brought to the laboratory in an insulated container. The surface of each liver is cleansed by swabs soaked in absolute alcohol and the liver is then placed in a small, 'Dettol'-sprayed chamber for dissection, which is carried out by means of sterile instruments. The extracted worms are placed separately in the portions of medium, which also contains a droplet of phenol red to indicate alkalinity. The tubed worms are then incubated at 37° C., with changes into fresh sterile medium as desired.

By this simple method it is possible to maintain *Fasciola hepatica* more or less normal in appearance and in a state of active movement for twelve days. So far, the worms have been killed by fixation at the end of this period, and there is a good prospect of keeping them in this state for fourteen days or longer. (Since this note was written, three isolated worms have been maintained in an active state for fourteen, fifteen and sixteen days respectively.) Moreover, it is now certain that worms can be obtained from excised livers of sheep in a sterile condition. Some failures are inevitable, but they are rare; in general, cultures remain sterile throughout. Whereas formerly[5] the conclusions drawn from physiological experiments with liver flukes maintained *in vitro* for

only three days have been far from convincing, because for most of this period the worms were in a dying condition, the prospect is now much more satisfactory, because worms are often more lively after they have been maintained *in vitro* for more than a week than they were on the first day after their removal from the liver. From a nutritional point of view the medium used is very imperfect; but its enrichment holds further promise of extending the period of survival *in vitro* of *Fasciola hepatica*, and providing a sound basis for physiological experiments.

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Seasonal Regulation in British Dragonflies

IT has long been recognized that the reproductive stages of different species of dragonflies tend to be restricted in incidence, each being characteristic of a given season. During the period 1950–53, the life-histories of several British species were studied with the view of determining the principal ecological factors responsible for their seasonal regulation.

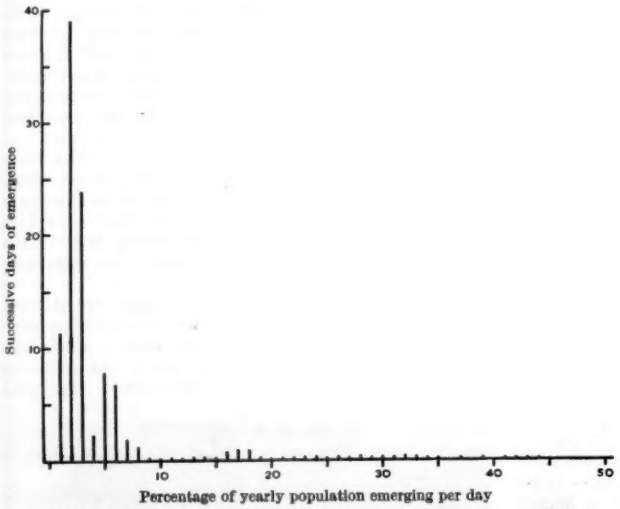

Fig. 1. Time-frequency distribution of adult emergences in a population of *Anax imperator* during 1953. Emergence began on May 25 and finished on July 7

In the Emperor dragonfly, *Anax imperator* Leach, it was found that, although larval populations showed a wide measure of temporal variation, yet emergence was restricted regularly to a period of about forty-five days each year, lying between mid-May and mid-July. The first fourteen days of adult life were spent away from water; after this, when sexually mature, adults returned to the aquatic habitat for reproduction. Oviposition extended from late June to early September. Adults did not survive the summer. The eggs hatched in about twenty-four days and larvæ were half-grown (*c.* 24 mm., instar 11) by October, after which low temperature prevented further development. In the following April growth was resumed, and the final larval instar (*c.* 50 mm., instar 15) was entered in August, approximately one year after hatching of the eggs. A diapause occurred in the final instar, and morphogenesis was suspended until diapause development had been completed in the autumn. This did not take place until the temperature had fallen below the threshold permitting metamorphosis. In this way it was assured that final instar larvæ embarked upon metamorphosis simultaneously, as soon as conditions became favourable in the spring. Thus, the temporal variation accumulated during the long period of larval development was effectively erased in the final instar. Eclosion, which directly succeeded metamorphosis, was closely synchronized, more than 90 per cent of the annual population of adults emerging within the first ten days of the emergence period (Fig. 1).

In this life-history the synchronization of emergence can be seen as a direct consequence of the diapause in the final larval instar. Recognition of this causal relationship means that species with a time-frequency pattern of emergence resembling that of *A. imperator* may be expected to feature diapause in the final instar and vice versa. This expectation has been confirmed in *Pyrrhosoma nymphula* (Sülzer)[1], the only other species of which the emergence curve is known throughout the flying season. Dragonflies typified by these two species have been termed 'spring' species, in contradistinction to 'summer' species in which a diapause, if present, is located elsewhere in the life-history. In summer species the final larval instar is usually entered in the year of emergence and, since growth is uninterrupted at this stage, larval variation finds expression in the emergence curve, which is temporally dispersed. Although not invariably the case, summer species usually emerge later in the year than spring species, since they have at least one extra instar to complete before commencing metamorphosis.

This ecological classification has been found to hold good throughout the British dragonflies, of which approximately half are spring and half are summer species. It corresponds with recognized taxonomic affinities at a generic level but shows departure when families are considered.

It is likely that the principles of this classification apply generally where there is a biological demand for rigorous seasonal regulation, and comparative treatment of other insect groups may throw an interesting light upon the colonization of temperate regions and upon the evolution of different types of life-history.

This work was financed by the Department of Scientific and Industrial Research, and is to be described more fully elsewhere.

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Direct Microscopy for Study and Count of Soil Protozoa

It is generally accepted that only direct microscopy is able to give a reliable estimate of the total numbers of micro-organisms present in soil. Suitable direct techniques have been developed for counting the bacteria, fungi[1] and algae[2]. No adequate technique is available for the protozoa. A recently developed culture technique[3] is a considerable improvement, but tends to be selective and is time-consuming in operation.

The direct examination of protozoa in soil has been made difficult by their low numbers and by the lack of a suitable differential staining technique. The following method overcomes these difficulties.

A known amount of 1 : 5 soil : water suspension is spread on a slide and fixed wet with osmic or formalin vapour. After drying, it is stained with erythrosin, washed, and then counterstained with methyl green. The preparation is mounted in immersion oil.

Colloidal particles in the soil appear green, protozoa pink with a purple nucleus. Flagella and cilia are readily visible. Contrast is sufficient to enable effortless counting with a low-power objective lens. The selective influence of cultural methods is eliminated.

The technique is of general use for soil studies. Bacteria, fungi and algae are stained purple and may be picked out quite readily against the green background of soil particles.

The details of this method will be published elsewhere.

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The Sorghum Midge Diapause

The sorghum midge, *Contarinia sorghicola* (Coq.), is an important pest of grain sorghums in Queensland, where its incidence and intensity of attack vary considerably from season to season and from early to late crops. Activity commences about two weeks after wet weather and high humidity, and crops flowering at the time may suffer severely. In central Queensland, where the rainy season is concentrated in late January and February, the mid-season crops are often damaged whereas those flowering in March and early April escape the pest. Farther south the wet season is not so well defined, although the peak often coincides with late flowering. In these districts the midge is seldom a pest of early and mid-season crops.

Laboratory experiments have demonstrated that larval diapause is broken and midge will emerge after the infested material is thoroughly wetted and incubated at relative humidities of 94–100 per cent, at temperatures of 25°–30° C. Emergence commences a fortnight after wetting, and may continue for a further four weeks. Under these conditions midge and its parasite, *Eupelmus australiensis* Gir., have emerged in appreciable numbers even from infested grain which had been stored for four years.

These laboratory findings are being correlated experimentally with midge behaviour in the field, and a full account will be published at a later date.

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Internal Infection of Tomato Seed by *Didymella lycopersici* Kleb.

Previous studies have indicated the importance of infected seed as a source of the stem and fruit rot disease of tomatoes caused by *Didymella lycopersici* Kleb. Hickman[1] reported 25–34 per cent infection of an outdoor crop grown from seed, a proportion of which was infected. Schoevers[2] demonstrated the presence of mycelium and pycnidia of the fungus on the seed coat and radicle of germinating seed, and Ogilvie[3] observed the fungus on the cotyledons and hypocotyl of tomato seedlings.

These studies were concerned with the location and effect of the fungus after germination had occurred. There appears to be little information, however, on the way in which the seed becomes infected and the location of the fungus on or in the ungerminated seed. Since such information is likely to be of value in determining the best methods of obtaining clean seed, a study has been made of the matter in the course of research now being conducted on the disease.

Sections of naturally infected fruit (var. Stonor's Money-Maker) bearing black lesions at the calyx end approximately ½–1 in. in diameter showed that the fungus had grown down the placenta and invested many of the seeds. Sections of the seeds revealed the presence of numerous hyphæ and pycnidia within the tissue of the funicle and also a more extensive internal invasion of some seeds. In these, the fungus had grown beneath the outer seed coat as far as the distal end of the seed and had formed numerous pycnidia. The main site of fungal growth was within the gaps which form between the layers of the seed coat as it matures. No fungal hyphæ were seen in the embryo. Dried seed from infected fruit also contained hyphæ and pycnidia.

Following these observations on naturally infected material, ripe tomato fruits (var. Radio) were artificially infected at the calyx end with a spore suspension from an isolate of *Didymella* known to be pathogenic to tomato stems. After thirty days, seed

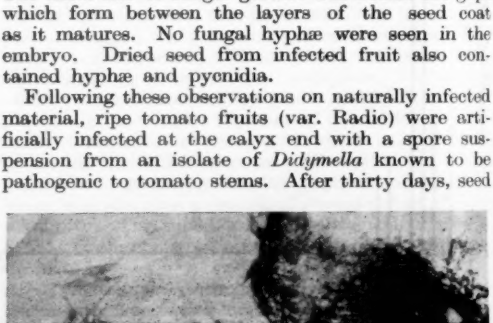

Fig. 1. Section of tomato seed (var. Radio) infected with *Didymella lycopersici* Kleb. showing hyphæ and pycnidia of the fungus in the funicle region and beneath the outer hairy seed coat. × 45

infection similar to that described above for naturally infected fruit was seen (Fig. 1). Isolations were made of the fungus from the inside of the infected seeds, and it was found to be identical with that inserted into the fruit.

Internally infected seed was found to germinate at least as well as comparable healthy seed.

These observations and experimental results indicate that the infection of tomato seed by *Didymella* is not solely due to external contamination by spores but also involves internal fungal invasion.

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Crystal Defects in Freshly Worked Surfaces

RECENTLY, it has been suggested[1] that the emission phenomena (Kramer effect) and the blackening of photographic plates (Russell effect) observed with freshly worked or evaporated surfaces of certain metals may be due to the presence of sites of low work function, since photoelectric emission can be observed in the visible range of light.

Using a number of overlapping optical filters of narrow band-width, the photoelectric response of such surfaces has been explored by means of an open-ended Geiger counter, operating in an air–alcohol mixture at 10 cm. mercury, and it has been found that with aluminium (abraded and evaporated) and zinc (abraded) an emission peak is present at a wave-length of 4700 A. Evaporated copper and gold were found to be inactive. From these and other experiments it was concluded that this selective photoelectric effect is found mainly with metals which are known to form 'excess-metal' oxides, such as aluminium, zinc or cadmium, and that the effect is due to the presence of crystal defects in the oxide. It is suggested that the selective photoelectric effect observed, and other associated phenomena, are due to oxygen ion vacancies acting as electron traps. The mode of formation of these imperfections in metal films, evaporated in the presence of traces of oxygen, is considered to be similar to that of 'additive coloration' used for producing *F*-centres in alkali halide crystals. The centres formed in abraded surfaces, on the other hand, may result from the encounter of an ion vacancy pair with a metal atom.

An oxygen ion vacancy is divalent; it would be expected, therefore, that it could accommodate one, two or three electrons. From experiments on the luminescence of zinc oxide, three impurity-levels at 3·1, 2·6 and 1·9 eV. are known to exist[2], and the 2·6-eV. level is probably identical with the impurity level at 2·64 eV. responsible for the selective photoelectric effect at 4700 A. The centres may therefore be identified with oxygen ion vacancies occupied by two electrons.

It appeared of interest to establish whether blackening of photographic plates (Russell effect) could be achieved with deformed ionic materials such as rock salt. Friction tracks were made on crystals of rock salt by sliding a hemispherical steel specimen over the surface. Blackening of photographic plates (Q2 Ilford) only occurred after the deformed part of the surface had been exposed to the action of

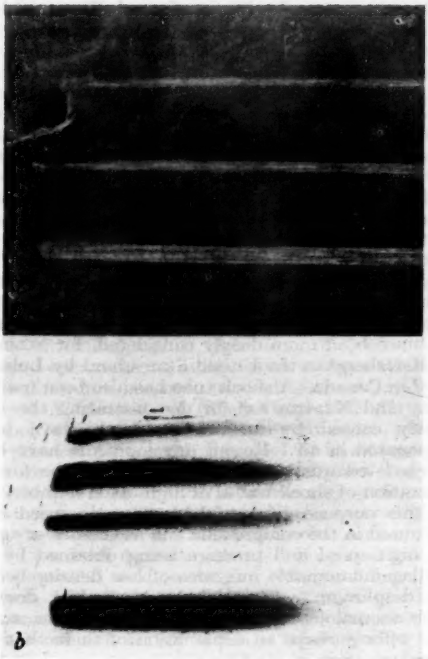

Fig. 1

X-rays. The formation of the image is not due to the action of hydrogen peroxide (Russell effect), as is the case with certain abraded and evaporated metals[3], since the interposition of a sheet of mica did not prevent blackening. It was concluded that the blackening of the photographic plate was due to luminescence centres which were formed during the irradiation of the highly deformed surface layer in the friction track. Fig. 1(*a*) shows micrographs of three tracks on a rock salt crystal made under three different loads and Fig. 1(*b*) shows the record obtained. Apart from the three black bands corresponding to the three friction tracks, a fourth band is strongly evident from a track made in a previous experiment, which had been thought to have been completely removed by washing the crystal with water. The fourth band indicates that deformation during the friction experiment extended to great depth.

From the response to photographic plates of various sensitivities, the range of wave-lengths within which the luminescence lies was estimated to be approximately 2000–3000 A., corresponding to a radiative transition of between 4 and 6 eV. This could be explained by a transition of an electron either from the *F'*-band to the valency band, or from the conduction band to an acceptor level of the V-centre type.

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Spontaneous Ignition of an Inflammable Gaseous Mixture on Release from Compression

The 'shock-tube' method of producing one-dimensional shock waves has found many applications in recent years. It was first used by Vieille[1] to study the establishment and propagation of discontinuous waves in columns of air. Payman and Shepherd[2] applied the method—in their 'bursting-diaphragm apparatus'—to examine, by means of schlieren photography, the nature and spread of the discontinuous disturbance in the expansion chamber. Their results[3] linking shock-wave speed and air flow with the initial pressure in the compression chamber fitted accepted theory. The theory of shock tubes has since been more deeply considered, for example, by Hertzberg[4] in the United States, and by Lukasiewicz[5] in Canada. A shock tube has also been used by Perry and Kantrowitz[6] for demonstrating the luminosity caused by an intense shock wave being propagated in air. Recent developments have been directed towards the use of the shock tube for the generation of shock waves of high Mach number, and for this purpose gases of high acoustic speed have been used in the compression end as the driver agent, the high speed and pressure being obtained by exploding inflammable mixtures of low density behind the diaphragm. Hertzberg and Smith[7] describe some anomalous results in such experiments, and it is to offer perhaps an explanation of these that this communication is made.

The underlying purpose of Payman and Shepherd's investigation was to study, in a simple way, the ignition of a gas mixture by a shock wave transmitted through the mixture, with the view of finding if the shock wave from a detonating coal-mining explosive could, *per se*, cause ignition if the explosive were fired in an atmosphere containing methane and air. An account of early experiments with methane – oxygen and with ethylene – oxygen mixtures in the bursting-diaphragm apparatus (made of drawn steel tubing 2·5 cm. in diameter, the mixture being in the expansion chamber, and air in the compression chamber) has already been published[8]. Ignition by the shock disturbance released by the rupture of the diaphragm was obtained over a wide range of oxygen mixtures with each of these two gases. With the most sensitive mixtures, bursting pressures of the order of 50 lb. per sq. in. sufficed to cause ignition. For most of these experiments diaphragms of copper were used; ignition was also caused when 'Cellophane' (and even strong paper) was used and also, with some mixtures, when the disturbance released by the rupture of the diaphragm had to traverse a column of air before reaching the explosive mixture; these experiments showed that ignition was not associated with any frictional or mechanical effect arising during the actual rupture of the diaphragm. The far end of the expansion chamber was fully open, so that pressure-piling effects associated with a closed end did not arise. Indeed, the schlieren photographs showed ignition was caused near to the diaphragm.

Attempts to ignite methane – air mixtures were unsuccessful, even with diaphragms bursting at 1,100 lb. per sq. in.; rather, they were unsuccessful in that a stab of flame observed (through windows in the expansion chamber) near the diaphragm did not develop into an established explosion accompanying the disturbance as it was propagated through the column of mixture. Evidence was collected which suggested that the spread of flame was prevented by an air gap interposed in the column of inflammable mixture by the dissolution of a vortex ring of air (from the compression chamber) travelling initially *through* the column of mixture, this vortex being the pioneering effect released when the diaphragm ruptured, by shearing cleanly around the periphery of the circle exposed to pressure. The formation of the vortex was a purely mechanical effect, and it always occurred. With sensitive or with strongly explosive mixtures, the explosion was readily transmitted across the gap, but this was not so with methane – air mixtures. Thus, the failure to establish flame in the latter mixtures might not have been due, physically, to a deficiency in the 'igniting power' of the shock wave. Experiments made to verify this explanation brought to light an interesting phenomenon.

It seemed reasonable to expect (though it would not provide conclusive proof of the explanation) that, if the vortex could be made to consist of an explosive mixture, its dissolution would not break the continuity of the inflammable column of methane – air in the expansion chamber. The apparatus was therefore modified so that the compression chamber could be filled with an explosive mixture, in the first place of methane and oxygen. The static bursting pressure of the diaphragm was known to within a few pounds per square inch, and the partial pressures to provide roughly the required mixture could be calculated. The oxygen was introduced first and then, quite slowly, methane was passed in through a perforated tube held axially along the chamber until ultimately the diaphragm burst. The exact composition of the mixture was calculated from the observed bursting pressure of the diaphragm. The expansion chamber, in the meantime, had been filled with the methane – air mixture. Very violent explosions, with flame spreading far outside the open end of the expansion tube (100 cm. long), were obtained with many combinations of mixtures in the two chambers. The point of interest, however, is that equally violent explosions were found to occur when the open expansion chamber contained only air.

This finding that ignition could occur when a compressed gaseous mixture was suddenly released into air was investigated further. The mixtures of methane and oxygen in the compression chamber were all on the lean side as a precaution against the destructive violence that seemed likely to develop with intrinsically more explosive mixtures under high compression. Experiments were made with a compression chamber 15 cm. long, and an air-filled open expansion chamber 100 cm. long. Selected results are shown in Table 1; there was in fact some scatter,

Table 1

Mixture in compression chamber: Per cent methane in oxygen	Mixture in compression chamber: Pressure at release (lb. per sq. in.)	Result in open expansion chamber
11·8	1,390	No explosion
13·4	775	Explosion
	600	No explosion
14·8	540	Explosion
	385	No explosion
15·5	283	Explosion
	245	No explosion
17·5	193	Explosion
	160	No explosion

and non-ignitions were sometimes obtained at pressures which were expected to give ignition.

It was found that the pressure on the release of which ignition occurred became progressively higher as the expansion chamber was shortened. Nevertheless, ignition was obtained with mixtures released directly into free air (for example, with a mixture containing 22·3 per cent of methane in oxygen, and a diaphragm bursting at 1,000 lb. per sq. in.).

A photographic investigation of the ignition of a mixture released from compression has not yet been made; however, ignition probably arose as a result of heat transfer from the air compressed and heated in the shock wave to the contiguous layers of explosive mixture (at first cooled by expansion) that formed the driver piston. There was no perceptible delay before ignition.

It seems possible that Hertzberg and Smith's results were confused by the occurrence, in some experiments, of spontaneous ignition when the diaphragm was ruptured before explosion had spread throughout the mixture in their compression chamber. Shock-tubes designed to operate on this phenomenon, with suitably chosen mixtures, might indeed extend their scope. Energy losses during explosion would be minimized, and the design of the tube itself might be simpler since the stressing of the tube would be less severe.

I wish to thank Mr. A. H. A. Wynn, director of the Safety in Mines Research Establishment, Ministry of Fuel and Power, for permission to publish these results.

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Use of Adsorption Columns in the Analysis of Emulsions stabilized with Non-ionic Detergents

Determination of the constituents of emulsions stabilized with non-ionic detergents has been hitherto restricted by the lack of a satisfactory method of quantitative separation. Following the methods outlined previously[1], a separation of such emulsions has been achieved and shown to be quantitative.

Using columns of 'Bio-Deminrolit' (an intimate mixture of 'Zeokarb 225' and 'De-Acidite *FF*') of 40–60 mesh, percolation of lanolin/'Lissapol *N*' emulsions containing up to 1 per cent of sodium chloride gave clear liquors, which on evaporation left no residue. Columns containing powdered animal charcoal as an added adsorbent were equally effective, but although the grease could be removed quantitatively, the 'Lissapol *N*' was held too firmly for successful solvent elution and, eventually, charcoal was omitted from the columns.

Preparation of the columns involves Soxhlet extraction of the resin with the solvents to be used for elution. The columns were prepared in the dry state in tubing 1·5 cm. diameter to give a length of approximately 10 cm. when wet. Satisfactory volumes of eluent were found to be 10 ml. for each 1 cm. length of column.

Elution with 50 per cent aqueous ethanol gave quantitative yields of 'Lissapol *N*', estimated by the method of Oliver and Preston[2]. Subsequent elution with trichlorethylene gave reproducible results for removal of lanolin. These two fractions were also identified with the original materials by their characteristic infra-red absorption spectra.

It would appear that the first step in breaking the emulsion is the removal of stabilizing electrolyte by the mixed resin, followed by adsorption of the grease and detergent. Evidence has been obtained that a chromatographic separation of grease and detergent occurs during elution with aqueous ethanol.

This procedure has been applied to the analysis of 'Lissapol *N*'/mineral oil (Shell Clavus oil 27) and 'Lissapol *N*'/vegetable oil (olive oil) emulsions, giving a 100 per cent recovery of 'Lissapol *N*' in all cases.

The method was further extended to the analysis of a 'Lissapol *N*'/soap/lanolin emulsion by using two separate columns. The 'Lissapol *N*' was separated as above on a column of 'Bio-Deminrolit' and eluted with 50 per cent aqueous ethanol. Soap and lanolin were separated and estimated on a column of 'Zeokarb 225'/charcoal, as described in a previous communication. 'Lissapol *N*' is strongly adsorbed by the charcoal and is not removed when eluting the fatty acid and grease components of the emulsion. A more detailed account of this work will be published elsewhere.

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Electrophoretic Movement of Higher Fatty Acids on Filter Paper

Attempts at the separation of higher fatty acids by paper chromatography have not, in the main, been successful, although Isherwood and Hanes[1] have studied the problem in relation to a number of straight-chain fatty acids, and Nunez and Spiten[2] have evolved a technique, using paper impregnated with olive oil, for chromatographic separation of such compounds. Apart from other considerations, the low aqueous solubility and the low dissociation constants of these acids presented the problem of finding an indicator which would be sensitive enough to enable their presence to be detected on paper. It has been found that the methyl red/bromthymol blue indicator of Duncan and Porteous[3] permits of the detection of small amounts (for example, about 80 μgm. of C_{16}) of acids up to C_{18} on paper. Considerably more care is required, however, in the colour development with the higher acids than with the lower members of the series.

The present work deals with the movement of straight-chain acids from C_{10} to C_{18} in ammonia solution, on paper, in a closed vessel under electro-

phoresis, and it has been shown that the observed rates of movement, under 6 V./cm., for the C_{10}, C_{12}, C_{14}, C_{16}, C_{18} acids were respectively 4·5, 1·5, 0·33, 0·07 and 0·0017 cm./hr. These observed velocities are presumably the result of the electro-endosmotic flow (approximately 1·6 cm./hr.), a differential adsorption of the acids on paper resulting in a range of R_F values and ionic mobilities of the organic acid anions. When these influences are taken into account, the ionic mobilities would appear to be 42·1, 22·5, 16·4 and 13·9 × 10^{-5} cm./sec./V./cm. for C_{16}–C_{18} respectively. It is not possible to say directly what the figure for C_{18} would be, because this acid is adsorbed so strongly on paper that we have been unable to determine its R_F value under the experimental conditions employed with the other acids, but the extrapolated value is of the order of 13·0 × 10^{-5} cm./sec./V./cm.

The above results for ionic mobilities may be compared with the corresponding figures of Gonick[4] and McBain *et al.*[5] (see Fig. 1).

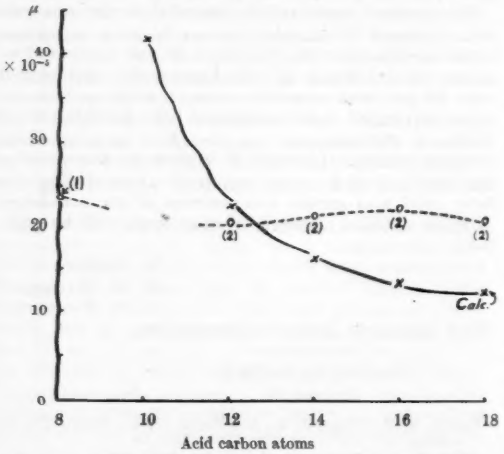

Fig. 1. Ionic mobilities of straight-chain higher fatty acids. ×—×, as determined by the electrophoretic method described; O—O, as determined by other workers: Gonick (2); McBain *et al.* (1)

Oleic, elaidic and stearic acids move at similar rates, and no separation of these from one another is possible; but it has been demonstrated, by the above electrophoretic method, that lauric and myristic acids are present in oleic acid B.P. to the extents respectively of 0·04 per cent and 1·5–2·0 per cent. In addition, another acid, so far unidentified, has been found in oleic acid B.P. which moves more quickly than C_{18} and more slowly than C_{14}. The existence of this acid was confirmed by chromatography[2]. A full account of this work will be published elsewhere.

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Production of Electric Power by mixing Fresh and Salt Water in the Hydroelectric Pile

When a volume V of a pure solvent mixes irreversibly with a much larger volume of a solution the osmotic pressure of which is P, the free energy lost is equal to PV. The osmotic pressure of sea-water is about 20 atmospheres[1], so that when a river mixes with the sea, free energy equal to that obtainable from a waterfall 680 ft. high is lost. There thus exists an untapped source of power which has (so far as I know) been unmentioned in the literature.

There are many methods (using osmotic and other forces) which might, in theory, be used for obtaining power by reversibly mixing fresh water and sea-water. In any such process, the extraction of the energy will cool the liquids by a fraction of a degree. The one which appears most practicable depends on the ionic nature of salt and uses membranes (incorporating ion exchange resins) selectively permeable to ions of one sign or the other. If such a membrane separates two salt solutions of different strengths, a potential difference appears across it.

If alternate layers of salt and fresh water are separated by alternate basic and acidic membranes[2], the membrane electromotive forces (each of order 30 mV.) are effectively connected in series, and an e.m.f. large compared with electrode polarization voltages can be built up.

An apparatus (the 'hydroelectric pile') has been constructed; in it 47 acidic and 47 basic membranes, each 8 cm. square, are separated by 93 spaces each 1 mm. thick. Fresh and salt water pass through a system of holes and washers and flow across alternate spaces between the membranes, and current is led off from compartments at the ends of the pile. A continuous supply of electricity is thus obtained. The fresh water becomes slightly salt during its passage through the pile, and the current drawn from the pile accounts for about 90 per cent of the salt transferred.

The maximum e.m.f. obtained has been 3·1 V.; the membranes used (of polythene mixed with resins based on cross-linked polystyrene) have resistivities higher than those of the pure resins, and give the pile an internal resistance of about 250 ohms at 10° C. The maximum external power obtained has been 15 mW. (at 39° C.).

The internal resistance is higher, and the power output is lower, at low temperatures. The pile is therefore likely to be more economic in a warm and equable climate. Its economics probably hinge on the time for which it will run before the membranes need replacing or the interior needs cleaning; the present pile has run satisfactorily for three months on $N/2$ sodium chloride solution and tap water.

This work was carried out at the Chemical Research Laboratory (Department of Scientific and Industrial Research), by permission of the Director of which this communication is published. The gift of membranes by B.X. Plastics, Ltd., and the assistance of the National Research Development Corporation, are acknowledged.

R. E. Pattle

"Rushmere",
Rydes Hill Crescent,
Guildford, Surrey.
May 31.

[1] Mikaye, Y., *Bull. Chem. Soc. Japan*, **14**, 55 (1939).
[2] Pattle, R. E., Brit. Pat. Application 1939/53 (Jan. 22, 1953).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, October 4

SOCIETY OF ENGINEERS (*in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1*), at 5.30 p.m.—Miss Marjorie Lovell Burgess: "The Influence of Murdoch on the Modern World".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (*joint meeting with the* LONDON SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY, *at the Chemical Society, Burlington House, Piccadilly, London, W.1*), at 6.30 p.m.—Mr. E. L. Streatfield: "Some Industrial Applications of Metal Cleaning".

Monday, October 4—Wednesday, October 6

SWISS FEDERAL COMMISSION FOR STUDYING HAIL FORMATION AND HAIL PREVENTION (at Zurich)—International Symposium on "Experimental Meteorology".

Tuesday, October 5

INSTITUTION OF GAS ENGINEERS (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—*Dr. Alexander Fleck—Murdoch* Memorial Lecture.

Wednesday, October 6

PHYSICAL SOCIETY, COLOUR GROUP (in the Physical Department, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 3.30 p.m.—*Prof. W. D. Wright*: "Colour Measurement Applied to Natural Phenomena, including a Report on Observations made during the Total Solar Eclipse, 30th June 1954".

SOCIETY OF CHEMICAL INDUSTRY (*joint meeting of the* CORROSION GROUP and MICROBIOLOGY GROUP, *at the Chemical Society, Burlington House, Piccadilly, London, W.1*), at 6.30 p.m.—Dr. F. Wormwell and *Mr. T. W. Farrer*: "The Influence of Micro-organisms on the Corrosion of Metals".

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6.45 p.m.—*Dr. H. M. N. H. Irving and Mrs. H. S. Rossotti*: "The Theoretical Basis of Sensitivity Tests and their Application to some Potential Organic Reagents for Metals"; Dr. H. M. N. H. Irving and Mr. R. G. W. Hollingshead: "An Investigation of 5-Nitriso-oxine as an Analytical Reagent".*

Thursday, October 7

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. J. Eccles: Presidential Address.

INSTITUTE OF METALS. LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Chairman's Address: "Some Men of Metallurgy".

ROYAL INSTITUTE OF CHEMISTRY. LONDON SECTION (at the South-East Essex Technical College, Longbridge Road, Dagenham), at 7 p.m.—*Dr. Tudor S. G. Jones*: "Chromatography—Theory and Some Applications".

Thursday, October 7—Saturday, October 9

SOCIETY FOR WATER TREATMENT AND EXAMINATION (at Bournemouth).—Autumn Meeting.

Friday, October 8

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—*Scientific Papers.*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PHYSICAL CHEMIST to work on macromolecules of biological interest—The Secretary, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3, quoting "Physical Chemist" (October 9).

LECTURER IN ANTHROPOLOGY at the University of Otago, Dunedin—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

LEVERHULME FELLOW AND LECTURER (with good experience of research work in nuclear physics) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Liverpool (October 16).

PRINCIPAL OF NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE—Clerk to the Joint Education Committee, Exchange Buildings, Nottingham (October 16).

PRINCIPAL (with bacteriological and immunological experience) OF THE WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (October 18).

CHAIR OF CHEMICAL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (October 25).

SENIOR LECTURER IN ANTHROPOLOGY at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 30).

SENIOR RESEARCH FELLOW (with a first-class degree in physics or electrical engineering and extensive research experience, preferably in high vacuum and electronic techniques); RESEARCH FELLOW with a first-class honours degree in physics or electrical engineering and good research experience); JUNIOR RESEARCH FELLOW (with a first- or good second-class degree in physics or electronics, with some research experience), IN THE DEPARTMENT OF INSTRUMENT TECHNOLOGY—*Prof. J. D. McGee, Physics Department, Imperial College*, Imperial Institute Road, London, S.W.7 (October 30).

ASSISTANT LIBRARIAN (preferably graduate in biology, with knowledge of German and French and with library experience) IN THE DEPARTMENT OF FORESTRY—Librarian, Department of Forestry, The University, Oxford (October 31).

LECTURER IN ANTHROPOLOGY, LECTURER IN GEOGRAPHY, and a LECTURER IN PHARMACY, *at the University of Sydney*—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

ASSISTANT LECTURER (preferably with experience in some branch of the organic chemistry of natural products) IN ORGANIC CHEMISTRY—The Registrar, University College of North Staffordshire, Keele, Staffs.

ASSISTANT (with a good honours degree in a biological subject and at least two years postgraduate experience in research, university teaching, or scientific administration), to be responsible for the biological sciences (excluding medicine) IN THE SCIENCE DEPARTMENT, *London Headquarters—The Director, Personnel Department*, British Council, 65 Davies Street, London, W.1, quoting "Biologist".

CHEMIST (with good honours degree, or equivalent qualification, industrial experience and the ability to prepare correspondence and reports) in the London Transport Central Laboratory, Chiswick, to be responsible for a section concerned with a wide variety of analytical and investigational work, dealing with detergents, cleaning materials, fire extinguishing materials, textiles and leathercloths, and many others—Staff Officer, London Transport, 55 Broadway, London, S.W.1, quoting F/EV507.

GEOLOGIST (with first- or second-class honours, division 1, degree in geology) IN THE GEOLOGICAL SURVEY DEPARTMENT, Gold Coast Government, for work in the field, on geological mapping and the application of geophysical methods to water supply and engineering problems—*The Adviser on Recruitment, Office of the Gold Coast* Commissioner, Melbourne House, Aldwych, London, W.C.2.

METEOROLOGIST (with first- or second-class honours degree in mathematics or physics and preferably with postgraduate experience in meteorology) *in the East Africa Meteorological Department*, for work including administration, forecasting and other technical meteorological duties—*The Director of Recruitment, Colonial Office, Gr at Smith Street, London, S.W.1, quoting CDE.57/88/01.*

PRINCIPAL or SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree in physics, engineering or mathematics, or equivalent qualification, and with experience in the field of microwave valves) *at the Ministry of Supply Radar Research Establishment*, Malvern, for work on the design and construction of millimetre wave magnetrons and other microwave valves, involving fundamental research into processes occurring in such valves and solution of technological problems on construction—*The Ministry* of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, *quoting A247/54A.*

RESEARCH ENGINEER (with a good honours degree or equivalent, and specialized knowledge and experience in fluid mechanics) for work on hydraulic torque converters and allied subjects—The Director, The Motor Industry Research Association, Lindley, near Nuneaton.

SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER (with H.S.C. or equivalent, and considerable experience of routine mechanical testing, particularly creep testing, and preferably familiar with vacuum techniques) at Culcheth, near Warrington, to supervise work in a creep laboratory using unconventional types of testing on a wide variety of metals and alloys involved in the construction of nuclear reactors—*United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 669.*

SENIOR PHYSICS MASTER—The Headmaster, Bradford Grammar School, Bradford.

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemistry or equivalent, and three years postgraduate experience of inorganic analysis), to take charge of a group engaged on research and development work in inorganic analytical chemistry, including the application of modern analytical methods (*Ref. 659*); SENIOR EXPERIMENTAL OFFICERS (with H.S.C. (Science) or equivalent and considerable experience in analytical chemistry), to supervise laboratories engaged on analysis of materials used in atomic energy processes (*Ref. 660*); and ASSISTANT EXPERIMENTAL OFFICERS (with at least H.S.C. in science subjects or equivalent and experience of chemical analysis, preferably in the inorganic field), for analytical work on materials used in atomic energy processes (Ref. 661) with *the United Kingdom Atomic Energy Authority, Capenhurst, near* Chester—U.K.A.E.A., Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting appropriate Ref. No.

SENIOR LECTURER (with wide experience of flight testing and flight research techniques) IN FLIGHT EXPERIMENTS—The Recorder, College of Aeronautics, Cranfield, Bletchley, Bucks.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Air Ministry: Meteorological Office. British Rainfall 1952: the Ninety-Second Annual Volume of the British Rainfall Organization. (Report on the Distribution of Rain in Space and Time over Great Britain and Northern Ireland, during the year 1952, as recorded by about 5,000 Observers.) Pp. iv+215. (M.O. 576.) (London: H.M. Stationery Office, 1954.) 25*s.* net. [77

Ministry of Agriculture and Fisheries. Bulletin No. 78: A Selected and Classified list of books relating to Agriculture, Horticulture, etc., in the Library of the Ministry of Agriculture and Fisheries. Pp. vi+90. (London: H.M. Stationery Office, 1954.) 3*s.* net. [77

Studies in Economics and Society. Monograph A4: Financial Effects of Labour Turnover. By Dr. Frank T. Pearce. Pp. ii+228. (Birmingham: The University (Research Board, Faculty of Commerce and Social Science), 1954.) 15*s.* [147

The United Africa Group. (Speech delivered in London by Sir Geoffrey Heyworth, chairman of Unilever Limited, and in Rotterdam by Dr. Paul Rykens, chairman of Unilever, N.V., at the annual general meetings of those companies on Monday, 31st May, 1954.) Pp. ii+20. (London: Unilever, Limited, 1954.) [147

British School of Archæology at Athens. Annual Report of the Managing Committee, for the session 1952–53. Archæology in Greece, 1952–1953. By J. M. Cook and J. Boardman. Pp. 64+4 plates. (London: British School of Archæology at Athens, 1954.) [147

Office of the Lord President of the Council. The Use of Towns' Wastes in Agriculture: a Study by the Natural Resources (Technical) Committee. Pp. iv+25. (London: H.M. Stationery Office, 1954.) 1s. 3d. net. [147

City and County of Bristol. The City Museum. Report of the Committee for the year ended 31 December, 1953. Pp. 16+2 plates. Stratford Mill in Blaise Castle House Folk Park. Pp. 8+2 plates. 6d. (Bristol: City Museum, 1954.) [147

Department of Scientific and Industrial Research. Report of the Mechanical Engineering Research Board, with the Report of the Director of Mechanical Engineering Research, for the year 1953. Pp. iv+64+4 plates. (London: H.M. Stationery Office, 1954.) 2s. 6d. net. [147

Air Ministry: Meteorological Office. Professional Notes No. 111: Nocturnal Winds. By E. N. Lawrence. Pp. 14. (M.O. 524k.) (London: H.M. Stationery Office, 1954.) 1s. net. [147

National Committee for the Defence of Children. Making Our Way: The Story of the Handicapped Children. By Peggy Jay. Pp. 12. (London: National Committee for the Defence Handicapped Children, 1954.) 6d. [147

Wool 1953–4. (The Annual Review of the International Wool Secretariat and The Wool Bureau Incorporated.) Pp. 95. (London: International Wool Secretariat; New York: Wool Bureau Incorporated, 1954.) [147

Empire Cotton Growing Corporation. Report of the Administrative Council of the Corporation submitted to the Thirty-Third Annual General Meeting on 9th July 1954.) Pp. ii+22. (London: Empire Cotton Growing Corporation, 1954.) [147

Assay and Detection of Pyrogens. (Report of a Symposium arranged by the Pharmaceutical Society of Great Britain and the Biological Methods Group of the Society for Analytical Chemistry, and held on December 11, 1953, at University College, London.) Pp. ii+44. (London: Pharmaceutical Press 1954.) [147

University of Cambridge: Department of Applied Economics. Third Report—Activities in the years 1951–1953. Pp. 20. (Cambridge: The University, 1954.) [147

Admiralty Ship Welding Committee. Report No. R.7: Structural Tests in Still Water on Riveted Dry Cargo Ship *Clan Alpine*. Pp. x+18+16 plates+116 diagrams+9 tables. 30s. net. Report No. R.6: Structural Tests in Still Water on Welded Dry Cargo Ship *Ocean Vulcan*. Pp. x+50+25 plates+109 diagrams+8 tables. 30s. net. Report No. R.11: S.S. *Ocean Vulcan* Sea Trials. Detailed Analysis of Record No. 6.W.5 (Ballast Condition). Pp. viii+12+124 diagrams. 27s. 6d. net. (London: H.M. Stationery Office, 1953 and 1954.) [147

A Glossary of Clay Trade Names. Compiled by Robert H. S. Robertson. Pp. 36. (Craigiebuckler: Clay Minerals Group of the Mineralological Society of Great Britain and Ireland, 1954.) [167

Mushroom Research Association Limited. Report for the year 1953. Pp. 47. (Yaxley, Peterborough: Mushroom Research Association, Limited, 1954.) 5s. [167

Wye College (University of London). Department of Hop Research—Annual Report, 1953. Pp. 72+1 plate. (Ashford, Kent: Wye College (University of London), 1954.) 4s. [207

Abstracts of Dissertations approved for the Ph.D., M.Sc., and M.Litt. Degrees in the University of Cambridge during the Academical year 1951–1952. Pp. xvii+243. (Cambridge: At the University Press, 1954.) [207

National Physical Laboratory. Notes on Applied Science No. 6: Volumetric Glassware: Scientific Aspects of Design and Accuracy. Pp. iv+22. (London: H.M. Stationery Office, 1954.) 1s. 6d. net; 40 cents. [207

Aero Research Technical Notes. Bulletin No. 139: Criteria for Designing Adhesive Bonded Joints. By William C. Broding. (Duxford: Aero Research Limited, 1954.) [207

Siemens Brothers and Co., Ltd. Engineering Bulletin No. 271/72 (June–September, 1953): Installing Cables in Malaya—Connaught Bridge and Bungsar Power Stations. Pp. 16. (Woolwich: Siemens Brothers and Co., Ltd., 1954.) [207

Other Countries

Development of the Agricultural Advisory Services in Europe since 1950. Pp. 97. (Paris: Organisation for European Economic Co-operation; London: H.M. Stationery Office, 1954.) 300 francs; 6s.; 1 dollar. [97

Polska Akademia Umiejetnosci. Katalog Polskiej Literatury Matematyczno-Przyrodniczej. (Catalogue of Polish Scientific Literature.) Tom 21 za lata 1945–1949. Pp. vi+441. Materialy do Fizografii Kraju Nr. 32: Rodzina *Eupistidae* Polski. (Family *Eupistidae* (Lepidoptera) of Poland). By Sergiusz Toll. Pp. 292+38 plates. (Krakow: Polska Akademii Umiejetnosci, 1952 and 1953.) 50.0 zloty. [97

Colony of Mauritius. Annual Report of the Observatory Department for the year 1952. Pp. i+13+1 map. 25 cents. Royal Alfred Observatory. Results of Magnetical and Meteorological Observations. Vol. 35, Part 1, January 1950. Pp. 14. Part 2, February 1950. Pp. 14. Part 3, March 1950. Pp. 14. Part 4, April 1950. Pp. 14. Part 5, May 1950. Pp. 14. Part 6, June 1950. Pp. 14. (Port Louis: Government Printer, 1953 and 1954.) [97

Symposium on Effects of Radiation and Other Deleterious Agents on Embryonic Development. (Given at Research Conference for Biology and Medicine of the Atomic Energy Commission. Sponsored by the Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, April 20, 1953.) (Reprinted from *Journal of Cellular and Comparative Physiology*, Vol. 43, Supplement 1, May 1954.) Pp. 337+6 plates. (Philadelphia: The Wister Institute of Anatomy and Biology, 1954.) [141

New Research Techniques in Physics. (Symposium organized by the Academia Brasileira de Ciencias and Centro de Cooperacion Cientifica para America Latina (Unesco), under the auspices of the Conselho Nacional de Pesquisas do Brasil, Rio de Janeiro and Sao Paulo, July 15–29, 1952.) Pp. xi+447. (Rio de Janeiro: Academia Brasileira de Ciencias, 1954.) [147

Les Limons Quaternaires du Bassin de la Seine: Stratigraphie et Archéologie paléolithique. Par François Bordes. (Archives de l'Institut de Paléontologie Humaine—Mémoire No. 26.) Pp. ii+472. (Paris: Masson et Cie, 1954.) [147

New Zealand. Department of Scientific and Industrial Research. Departmental Handbook. Second edition. Pp. 68. (Wellington: Government Printer, 1954.) [147

Australian Journal of Marine and Freshwater Research. Vol. 5, No. 2: Dinoflagellates in the Australian Region. By E. J. F. Wood. Pp. 171–352. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1954.) 7s. 6d. [147

United Nations. Urban Land Problems and Policies. Housing and Town and Country Planning—Bulletin 7. Pp. 182. (New York: United Nations; London: H.M. Stationery Office, 1954.) 1.75 dollars; 12s. 6d. net; 7 Swiss francs [147

United Nations. Catalogue of Economic and Social Projects of the United Nations and the Specialized Agencies—No. 5, 1954. Pp. viii+157. (New York: United Nations; London: H.M. Stationery Office, 1954.) 12s. 6d. [147

3-Dimensional Field Theory. Originated by Morris J. Spivack. (Third printing, May 1954, of the Vital Correlations 3-Dimensional Unified Field Theory—exactly as published by the Vital Correlations Foundation for the Unification of Knowledge in 3 Dimensions, established at Ithaca, N.Y., December 6th, 1952.) (Publication No. 8.) Pp. 22. (Brooklyn, N.Y.: Morris J. Spivack.) [147

México al Trabajo Fecundo y Creador. By Adolfo Ruiz Cortines. Pp. 30. Tres Discursos. By Miguel Alvarez Acosta. Pp. 35. La Clinica de Conducta y los Ninos Problema: Contribucion al Estudio de la Inadaptacion Escolar en Mexico. Pp. 80. (Mexico, D.F.: Secretaria de Educacion Publica, 1954.) [147

Mitteilungen des Deutschen Wetterdienstes. Nummer 9 (Juni 1954): Windschutzanlagen auf der Hohen Rhön. Von Dr. Siegfried Uhlig. Pp. 17. (Bad Kissingen: Deutschen Wetterdienstes, 1954.) [147

Canada: Department of Agriculture. Annual Report of the Forest Insect and Disease Survey, Forest Biology Division, Science Service, 1953. Pp. 158. (Ottawa: Queen's Printer, 1954.) [147

Geological Survey of the Anglo-Egyptian Sudan. Report for 1952–1953. Pp. i+20. (Khartoum: Sudan Government Geological Survey, 1954.) 25 p.t.; 5s. [147

United Nations. Technical Assistance Committee. Sixth Report of the Technical Assistance Board. (Economic and Social Council—Eighteenth Session—Supplement No. 4.) Pp. vii+267. (New York: United Nations; London; H.M. Stationery Office, 1954.) 2.50 dollars; 17s. 6d. net.; 10 Swiss francs. [147

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Serien, Band 5, Nr. 2: Meridian Observations of Miscellaneous Stars—Observations of Stars contained in Boss' General Catalogue, Stars connected with Galactic Nebulae, and Variable Stars, made with the Repsold Meridian Circle of the Lund Observatory during the years 1939–44, and reduced to the Equinox of 1950. By Sven Cederblad. Pp. 34. (Stockholm: Aimqvist and Wiksells Boktryckeri AB.; London: H. K. Lewis and Co., Ltd., 1954.) 5.25 kronor. [147

Bulletin of the American Museum of Natural History. Vol. 104, Article 3: The Species of the Genus *Hydriomena* Occurring in America north of Mexico (Geometridae, Larentiinae). By James H. McDunnough. Pp. 237–358+plates 1–3. 1.75 dollars. Vol. 104, Article 4: Endocrine Imbalance and Tissue Hyperplasia in Teleosts Maintained in Darkness. By Priscilla Rasquin and Libby Rosenbloom. Pp. 359–426+plates 4–23. 1.25 dollars. Vol. 104, Article 5: Reproductive Behaviour in the Gobiid Fish *Bathygobius Soporator*. By William N. Tavolga. Pp. 427–460+plates 24–31. 75 cents. (New York: American Museum of Natural History, 1954.) [167

United States Department of Agriculture. Leaflet No. 365: Wasps: How to Control Them. Pp. 8. (Washington, D.C.: Government Printing Office, 1954.) 5 cents. [167

Transactions of the American Philosophical Society. New Series—Vol. 44, Part 2: Forgotten Leaders in Modern Medicine: Valentin, Gruby, Remak, Auerbach. By Prof. Bruno Kisch. Pp. ii+139–318. (Philadelphia: American Philosophical Society, 1954.) 2 dollars. [167

Museum of Comparative Zoology at Harvard College. Breviora. No. 33 (May 14, 1954): Systematic and other Notes on some of the Smaller Species of the Ant Genus Rhytidoponera Mayr. By William L. Brown, Jr. Pp. 11. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) [207

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 111, No. 7: The Reproductive System and Early Embryology of the Nudibranch *Archidoris Montereyensis* (Cooper). By John A. McGowan and Ivan Pratt. Pp. 259–276+2 plates. Vol. III, No. 8: A Key and Description of the Living Species of the Genus *Podocnemis* (*Sensu* Boulenger) (Testudines, Pelomedusidae). By Ernest Williams. Pp. 277–296. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) [207

The Discovery of Unicellular Life. (Excerpts from Communications by Antoni van Leeuwenhoek to the Royal Society of London (September 7, 1674 and October 9, 1676).) (Reprinted from the "Collected Letters of Antoni van Leeuwenhoek." Vols. 1 and 2, 1939 and 1941. Edited by a Committee of Dutch Scientists and published by Messrs. Swets and Zeitlinger, Ltd., of Amsterdam.) Pp. 14. (Waltham, Mass.: Chronica Botanica, Co., 1954.) [207

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 29, Part II: Studies in the Bromeliaceae, 17. By Lyman B. Smith. Pp. vi+521–542. (Washington, D.C.: Government Printing Office, 1954.) 20 cents. [207

East Africa High Commission. East African Medical Survey Annual Report, 1953. Pp. ii+16 (2 plates). Filariasis Research Annual Report, 1953. Pp. ii+22 (2 plates). (Nairobi: Government Printer, 1954.) [207

Svenska Linné-Sällskapets Årsskrift. Årgång 36, 1953. Pp. iv+764. (Uppsala: Aimqvist and Wiksells Boktryckeri, AB., 1953.) [207